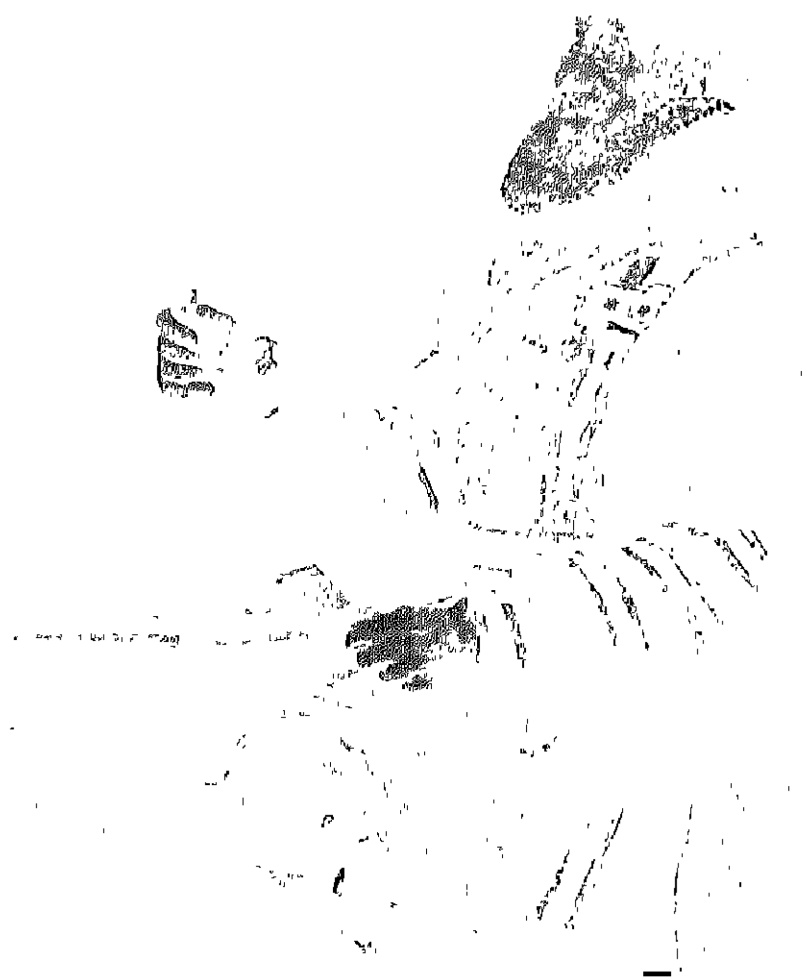
THE PRACTICAL JUNIOR TEACHER



THE YEOMAN OF THE GUARD
(after Sir John Millais, R.A.)

By courtesy of *National Gallery, Millbank, London*

Frontispiece

THE PRACTICAL JUNIOR TEACHER

A Guide to the Most Modern Methods of Teaching Children in the Junior Schools

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Contributions by Leading Authorities in Every Branch of Junior Education, with Numerous Illustrations, Schemes of Work, and Practical Suggestions

VOLUME III

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(*By D. M. Gill, M.A.*)

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"The subjects chosen for inclusion in any syllabus for the Primary School should not be confined to British history The tendency in the Primary School is to approach history through topics which may serve as an introduction to, and illustration of, the different stages of civilization . . . the subject-matter connected with each topic should also be such as makes a natural appeal to the youthful mind. . . . For the final stage . ' the work should consist mainly, if not wholly, of topics selected from British history"—REPORT ON THE PRIMARY SCHOOL, 1931

THE reorganization of the schools, in accordance with the recommendations of the Hadow Report, so that there is a clear-cut division between Infant, Junior, and Secondary Schools, gives a chance to the teacher in the Junior School to plan out a syllabus to cover the four years of a child's life there, a syllabus complete in itself and yet such that it will lay the foundation for future work in the Secondary School.

Junior textbooks, while they should be complete in themselves and following the same course as the syllabus, are most useful if they do not merely re-tell the same stories but serve as a complement to the stories prepared and told by the teacher, stimulating activity work. The stories told in later sections here are complementary to those, for example, in the *Pioneer History Series*.

Principles of Syllabus Construction

While there can be no one syllabus which is the best for all schools, since the teacher's interests, the particular locality, and the type of school are factors that must be taken into consideration, there are certain general principles which must be borne in mind in the framing of all syllabuses.

History is so wide that the content of the syllabus depends on what is considered to be the value to the child of learning history.

One obvious aim of history teaching is that the child should have a definite knowledge of the outstanding events of the past, particularly of those which have influenced modern ways of thought and conditions of life. It follows from this that the syllabus should include only the important happenings of the past and omit the trivial.

A second value of the teaching of history is moral training. Children are imitative both of the people that they meet in actual life and of the people they hear about in their story lessons of all kinds. All the qualities we would have them possess and all the meannesses we would have them avoid are shown in action by the various characters in history that they meet. There is no need for the teacher to draw the moral: children are born moralizers. Unconsciously, and therefore most easily and most effectively, the character and moral judgment of the children are developed by their history lessons.

A third aim is the development of the imagination and reasoning powers of the children. In the history lesson they learn to put themselves, in imagination, into the places of people they have never seen, who lived under conditions wholly different from their own. This capacity to put themselves into the place of other people will make them in later life sympathetic and pleasant to deal with. It is an essential quality for the citizens of a world-wide empire. The children also see in history the working out of the law of cause and effect. They learn to ask not only how certain events happened but also why they happened. Mathematics provide a training in abstract reasoning, but history affords a training in reasoning about human nature.

If the children are to gain from their history lessons this development of imagination and reasoning power, it follows that the material presented to them must be such that they can imagine it and reason about it: it must, that is to say, appeal to the interests natural to their age.

Suitable Material for Juniors

Children are always interested in stories about people. They are not, as long as they are in the Junior School, interested in historical movements such as the Renaissance or in institutions such as Parliament. For the children to comprehend these they must be enriched with interest reflected from persons. It follows that the History Syllabus in the Junior School should consist chiefly of the stories of great men and women of the past. These heroes must be selected with care. Children can appreciate courage and physical prowess so that such stories as those of Joan of Arc and Columbus never fail to have an entranced audience, but the lives of other types of great men, for example men who have deeply influenced thought, such as Socrates and Calvin, can hardly be made comprehensible and must therefore be omitted.

Children are interested not only in heroes of the past, but in the ways in which people lived. Modern conditions of life are complicated, and are therefore too difficult of comprehension for the children. For this reason earlier history is the more suited to the children's stage of development, and only at the end of their Junior School career are they ready to tackle modern history.

Stories of Prehistoric Peoples

From the foregoing considerations it is obvious that the best introduction to history for the children is the story of prehistoric man. A knowledge of this period of history is not in itself of great importance. At a later period of the child's schooling it might not be worth while to spend long over it, but at this stage it is of much value because our prehistoric ancestors were finding out just what the children themselves want to know. So the children can really think about the problems of prehistoric man and discover for themselves the solutions. They can understand the instincts of prehistoric man, hunger for food and fear of the wild animals, whereas they cannot comprehend the motives of more civilized grown-ups. Prehistoric work also provides splendid scope for handwork and dramatization, and "activity work" generally.

Classrooms in which this work is proceeding are usually scenes of great mental activity. The children put themselves imaginatively into the place of Stone Age man; they devise means to kill Sabre-tooth; they make weapons at home and bring them to show their teacher; they think out possible materials for making baskets and invent ways of weaving them.

In this course, then, the two chief interests of the children are combined, their love of a

story and their curiosity as to how people lived. The teacher tells only the connecting threads of the story, leaving the children to puzzle out, with hints when absolutely necessary, the devices of prehistoric man. Unless the children are thus left to think, there is little value in the

FIG. I
The Stone Age Boy

course. If, however, the child realizes at this stage that in the history lesson his co-operation is required, he has from the beginning the right attitude, and will pursue the subject actively.

Greek and Roman History

The study of prehistoric man should not last more than a year, if as long. The problem then arises what to take next. Some argue that this is the right stage to begin early British history, but others hold, perhaps with more justice, that children ought to know something of Greek and Roman history and that this is the best time to insert it in the course.

There is much in Greek and Roman history which the children can easily appreciate. They will enjoy parts of the story of the siege of Troy, which forms the natural introduction to both Greek and Roman history. They will find it interesting to contrast the way of life of the Spartan children and grown-ups under the institutions of Lycurgus with ways of life to-day. They will be thrilled by the story of the gallant fight made by the small cities of Athens and Sparta against the might of the Great King, the King of the Persians, and their sympathy will be unreservedly on the side of the Greeks. This is all to the good, for children of this age are not yet ready to see that there is usually much to be said for each side. It is the special business of the teacher of history to see that the children come to this point of view by the end of their school career. Other portions of Greek history suitable for use at this stage are the lives of Pisistratus and Alexander the Great, and certain dramatic episodes from the Peloponnesian War.

It is the legends of early Roman history that are particularly valuable for use with young children because the motives actuating the heroes are clear-cut. The stories of Romulus and Remus, Horatius, Lucius Quinctius Cincinnatus, Coriolanus and Scaevola never fail in their appeal. The story of Hannibal is interesting in itself, and it affords useful training because it is one in which the children's sympathies are divided. They have already learnt to look upon the Romans as heroes and so they want them to win. Yet they cannot help admiring the audacity and endurance of Hannibal and the Carthaginians. Parts of the story of the Gracchi and the lives of Caesar and Augustus should also be taken.

It is obvious that this is the stage at which Greek and Roman myths should be taken with the children in story time.

A Progressive Course of European and British History

After the Greek and Roman history stories the next part of the syllabus should logically and chronologically consist of British and European history, planned in such a way that it covers the remainder of the time spent in the Junior School.

Two points call for note here. The first is that this syllabus should provide fresh work for each year. There should be in it no vestige of the old "Concentric System," according to which the whole of British history was covered every year, variety being made either by the inclusion of a fresh series of heroes, or by the stressing of different aspects of history. The merit of the old system, the inculcation of the main facts of British history into the minds of the children, can be retained by new methods. The drawbacks of the "Concentric System" are obvious. If any attempt is made to cover the whole of British history in a year much of great historical value must be omitted. The lesson tends to become a mere recital of facts instead of a true story, and all the interesting details, beloved by the children, must be omitted to save time. Again, the children have a slightly bored feeling because they have heard the story before, and they remember just the dramatic moments, and want to narrate them before the lesson has well begun. If they are permitted the story is spoilt for those who do not know it, and if they are not permitted they are inclined to be sulky and unwilling to listen.

The other point to be noted is that, it is suggested that heroes of other nations should be included. In the past the tendency has been to concentrate attention on British history till the children insensibly gained the idea that other countries only existed as the enemies of Britain. To correct this insular prejudice, European history must somewhere be introduced

into the syllabus. It seems a sound plan and an easy one to include in this course of stories about heroes the outstanding men and women of other countries.

What to Omit from Junior Syllabus

There are three aspects of history that should be omitted from a syllabus for the Junior School,

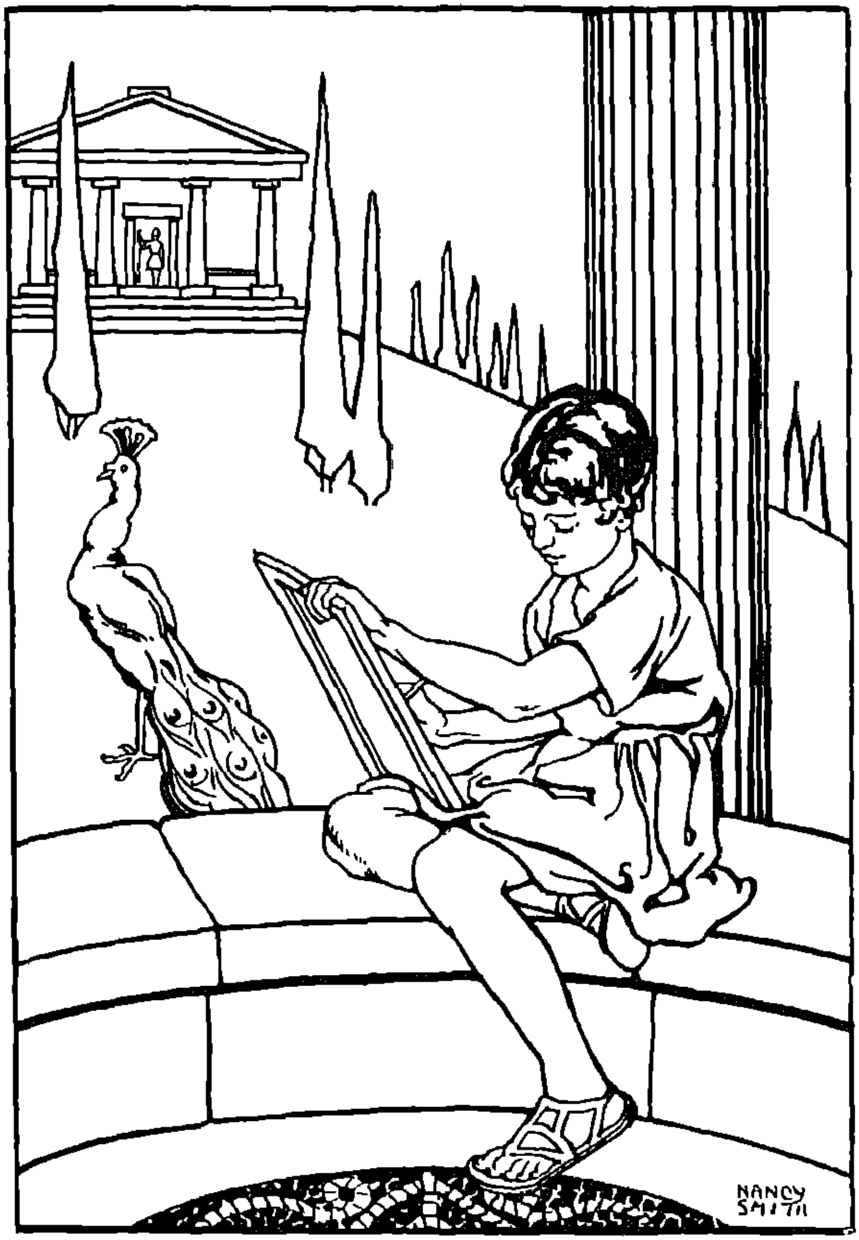


FIG. 2
The Roman Boy

not because they are unimportant but because they are incomprehensible to the child, or largely so.

In the first place constitutional history is too difficult to be more than mentioned in passing The important clauses of Magna Charta can easily be learnt from Kipling's poem, "The Reeds of Runnymede." Some constitutional questions can be made partly intelligible by a reference to school rules, and the need for obeying them, or by talks on the position of a prefect in the class.

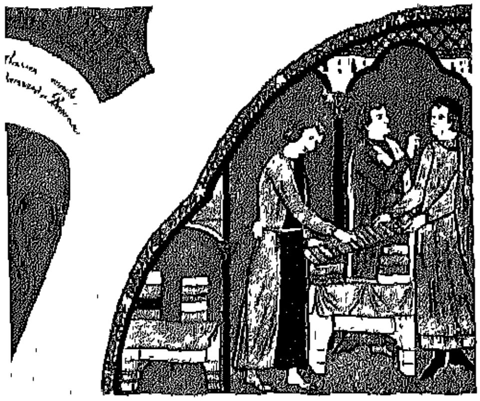
In the second place, children cannot grasp the causes of religious strife, so that any reference to them must be slight. They will be interested in the life of Luther, particularly as he was a man whose thought was always translated into action, but they cannot understand the fundamental differences between Catholicism and Protestantism The story of Wyclif and the Lollards and the life of Calvin do not appeal to them, and therefore must be left out. Children are, however, interested in the story of St. Augustine's mission to England and in the life of St. Francis of Assisi, in which there is no element of controversy.

Thirdly, there is no need to cover the whole of history with equal thoroughness. Stress the times when there was progress; pass lightly over times of disorder and civil strife. For example, it is unnecessary to speak in detail of the civil war between Maud and Stephen. The nineteen long winters of Stephen's reign, when it was said that "God and His Saints slept," should merely be used to make the sombre background against which the reforms of Henry II stand out with the greater brightness. Again, the Wars of the Roses form a sordid tale, and the names and dates of the battles are a sore burden to the memory. Make Warwick the Kingmaker the centre of interest. The whole will serve to throw into high relief the shrewdness of Henry VII, who brought these troubles to an end.

Local History

There are those who suggest that the best way to make history alive to the children is to give them a course in Local History. There is much to be said for this point of view if the children live in a locality which bears upon it the plain marks of history. It would be throwing away an obvious advantage if teachers in such cities as Chester, Gloucester, London, and Exeter failed to tell the stirring story of the events which have happened on the spot and in the vicinity Many Junior children, however, live in places where they would gain little from a consecutive course in local history.

On the other hand, every teacher should study the locality in which she is teaching, and find out what examples of general history she can find. A teacher in the Sussex Downs district can always find and explore examples of local



By courtesy of *La Bibliothèque Nationale, Paris*

FIG. 3

Fourteenth Century: Preparations for Weaving

(Probably choosing samples of wool)

British camps. A study of the Ordnance Survey map will reveal in almost every district a neighbouring stretch of Roman road. A teacher in an old village will be able to find out where the three open fields were before the land was enclosed, and with this information she can make more real the lessons that she gives on the three-field system of the Middle Ages and the enclosures of the eighteenth century. An old village church provides a textbook on architecture. Children in Lancashire naturally take a keen interest in the Industrial Revolution, since they see its results all about them. These are but a few examples of the way in which a teacher can use local examples of general historical matters.

Apart from this, it is well worth while to describe in much greater detail than usual any event in the general history of the country that took place in the locality, and then, if it is feasible, arrange a school journey to the spot. The dullest child may feel a thrill at being in the

FIG. 4
The Boy Who Lived in a Manor House

actual place where the event happened, especially if the event was of a stirring kind. It may be that history will suddenly become alive to him if he makes his own book of local history.

A Local Survey

Perhaps the most interesting way of treating local history is to set the children to make a survey, dividing the work in such a way that each child has something for which she is responsible, but making it so clear that this is a piece of co-operative work that a child who discovers some fact which belongs to a section of the work other than her own produces it for the common stock of information.

To any local survey there is the geographical and the Nature study side, and mathematics must be used for measurement. The study of the locality, therefore, may well be made a centre of interest to last for a year.

On the historical side, let some of the children find out by visits to a local museum and by inquiry from their elders what historical remains there are in and near the school, such as a British camp, a Roman villa, a manor house, or old church or shops.

Direct other children to read about the historical events which took place in the neighbourhood and visit the spot.

A Country School. The architecture and history of the village church will provide a subject for study for some children, while others can be detailed off to glean from the oldest inhabitants information about wells and streams and any folk-lore connected with these, the names of the fields and the reason for the names, and details about any old local customs that survive.

Other members of the class may engage in a study of the lives of village worthies.

FIG. 5

Ladies' Dress : Fourteenth Century

When the information has been collected the children should write it down, illustrating their accounts by post cards and photographs wherever they are available. Simultaneously a history map should be made, showing the places where historic events happened, and where finds of, for example, prehistoric weapons have been made.

For further suggestions on the subject see "Village Survey Making" (Ministry of Education Educational Pamphlet No. 61, H.M.S.O., 3d).

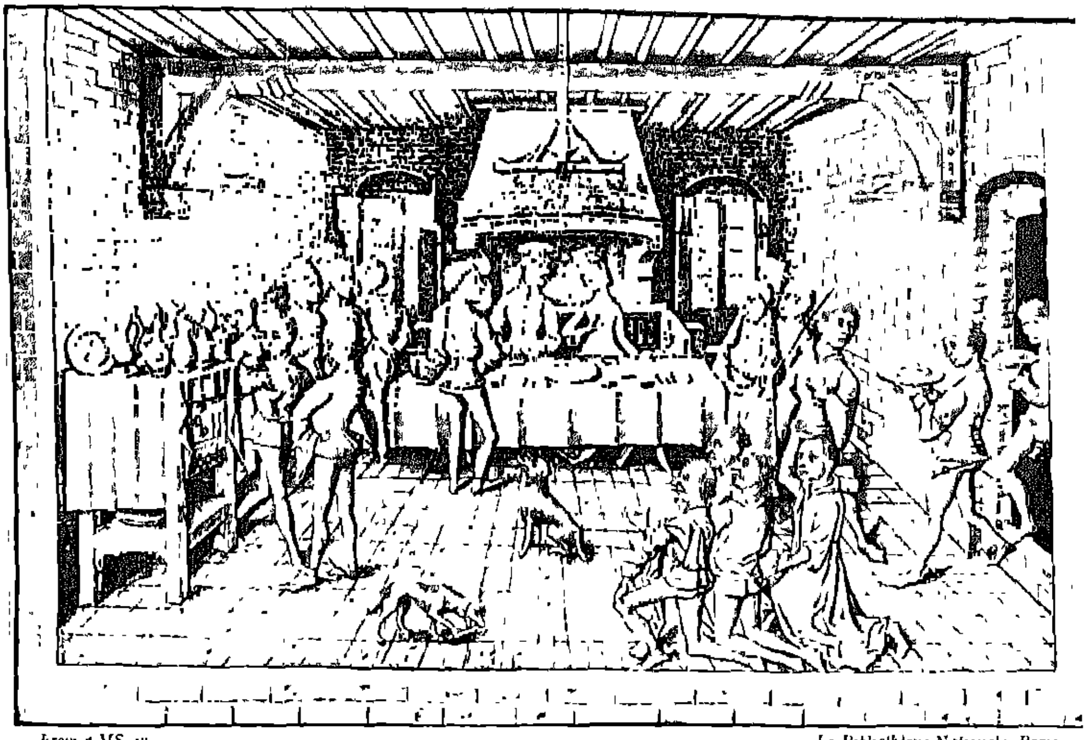
A Town School. The plan for a study of a town is somewhat different. The children's objective will be to gather information about

the guilds in the medieval town, any industries for which the town was once famous, and the differences made to the town, its people and industries, by the Industrial Revolution.

It is obvious that the teacher must have a very fair idea of what the children are likely to find if she is to direct and apportion the work undertaken. She must also collect as large a number of books on the locality as possible for the children's use for reference. The children, however, should think at the end that they have been the discoverers, and not suspect to what extent they have been guided.

Social History

Of recent years historians and teachers have realized the importance and interest of social history, and in some syllabuses there appears a separate course on it. On the whole, however, it proves more effective in practice to work in social history with political history. One of the surest ways of keeping the children's interest is to give them such variety that they never know what kind of a lesson to expect next, and this is best achieved by taking all aspects of history in the same course. The children are much interested in the three-field system of agriculture, in the appearance of medieval towns, in medieval markets and fairs, if lessons on these topics are interspersed amid lessons on the lives of heroes. They are, however, inclined to grow weary if they follow a separate course in social history, because in this the story element is lacking.



From a MS in *La Bibliothèque Nationale, Paris*

Fig. 6

A Fifteenth Century Artist's Impression of Charlemagne's Delegates being Received by Geoffroi

There is practically no attempt at historical accuracy here, the costumes and surroundings being those of the fifteenth century. Notice the V-neck, one of the earliest attempts at shaping garments which is typically fifteenth century.

There is a further advantage in running political and social history concurrently, in that the children remember that the townspeople of —— (a local town) earned their living in such and such ways, and that the villagers of —— did their farming in such and such ways at the time when Edward III began the Hundred Years' War with France Unless the social history is thus linked with the political the children are apt to have no sense of chronology and definiteness about the social history they learn

A knowledge of costume, armour, weapons, architecture, and ships forms part of history, but separate lessons on these matters are not advisable. In describing the hero of the story work in a description of the typical dress of the man of that age and class, and of his weapons and armour, if he used them. When a battle is about to take place between two widely different foes, pause a moment to contrast the appearance and equipment of the opposing armies. Take the opportunity of the Battle of Sluys at the opening of the Hundred Years' War to describe the ships of the time and the methods of warfare at sea. Explain how some typical castle was attacked and defended when an occasion presents itself. Illustrate the lessons with *accurate* pictures wherever possible. If social history is introduced in this way, apparently casually but in reality by design, it will be easily remembered because it is connected with the life history of a hero.

It is obvious that if the stories are amplified in this way it will not be possible to take a fresh character every lesson. That does not matter. It is much better to give the children an impression of the age from the life of one man described against a clear background of the times than to skim over the lives of more men, or to devote separate lessons to the details of the social life of the period

The real significance of imperial history lies in the self-government which exists within the Empire, and this is beyond the comprehension of children of eleven. In the Junior School, however, the foundations of a knowledge of Empire can be laid by telling the stories of such men as Wolfe, Clive, Warren Hastings, Captain Cook, and Livingstone.

History and Handwork

The value of handwork in connection with history is very great. To do any form of handwork the child's mind must be active. Children can passively listen to stories and passively look at pictures without exercising their minds at all, and therefore without learning anything. As handworkers they are artists, creators. They must work, or their idleness is apparent. When they begin to construct they find out the difficulties men in the past worked to overcome, they find out their own ignorance, they ask questions, listen to and work on the answers till they have constructed a model.

Handwork is useful in illustrating history, but it is not history. To devote a large amount of history time to handwork is a mistake. History handwork should be done in handwork time, or at home, as a general rule. Even though the children think more easily in plasticine and other materials than in abstract thoughts they must learn to think abstractly, and the history lesson should give them practice in so doing.

History and Dramatic Work

There is value in the dramatic method of teaching history provided that it is used with strict moderation. There is a definite syllabus which must be covered in the all too short years of a child's elementary school life, and dramatic work is too costly of time to be indulged in frequently.

Most useful is the bit of impromptu acting or miming in the last eight minutes of a lesson, without properties and perhaps without words, for small children find it difficult to think of words, and older ones know that their words are inadequate. Children are often shy when they are first introduced to dramatization, but this wears off, especially if the teacher at first takes a part, even a leading part, by means of which she can guide the other actors.

If something more elaborate is purposed, if, for example, another lesson is to be devoted to dramatizing the story, it is of great educational value if the teacher discusses with the children the division of the story into scenes and the characters who will be required in each. In this way the children have to think over the story.

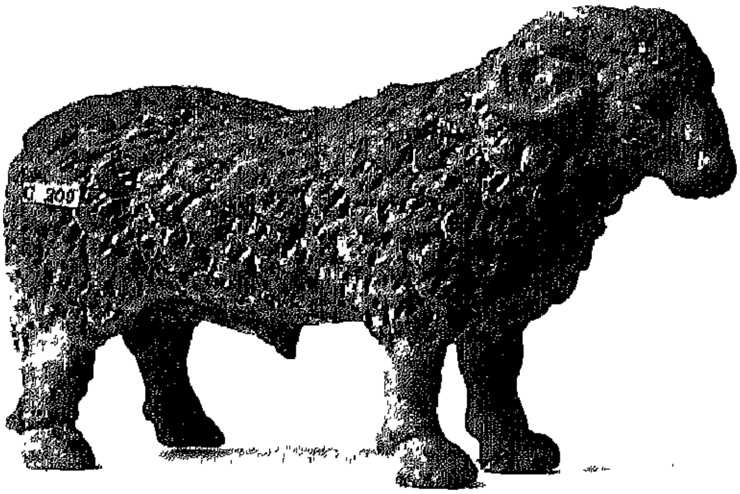
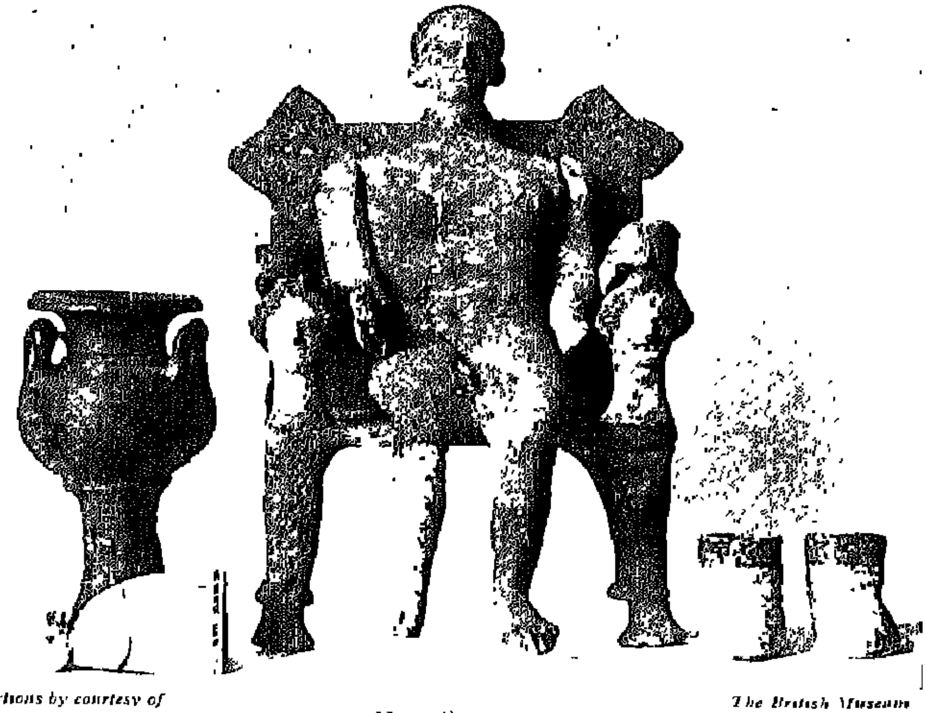


FIG. 7

Ancient Greek Terracotta Toy Animal



Reproductions by courtesy of *The British Museum*

FIG. 8

Ancient Greek Doll and Doll's Chair

Notice the little doll's shoes. In front of the tiny urn is a miniature of the shaped instrument which a Greek woman fitted over her knee, and on which she rubbed her wool before spinning it.

For this more elaborate dramatization properties are useful. Both in this section and in Volume IV hints are given for making costumes and simple weapons. Children enjoy making, both at home and at school, things worn and used by people of long ago.

Illustrations

Large pictures for class use provide in concrete, often dramatic form, material about which the children can think and talk. Instead of the teacher's taking up much time with the description of an event, which, however careful she is in her choice of words, is liable to be misunderstood, the children see in picture form the event happening, as it were, before their eyes, and they become the narrators. The picture itself interests them first, then they become engrossed in the story; because they are interested they think, and, because they have thought and not merely listened, they remember.

In Volume I (p. 260) a method of squaring up small illustrations, in order to reproduce them easily in a larger size, is described and illustrated. Many of the illustrations in this section may be so treated. Smaller illustrations may be shown either in groups or may be put up on the classroom walls. The PRACTICAL JUNIOR TEACHER History Time Charts illustrate a pictorial method which may well be carried out on a larger scale, the drawings being attached and varied from time to time. The Charts are issued with this Volume.

By courtesy of *The British Museum*

FIG. 9

Treading Grapes in the Sixteenth Century

From a Contemporary Calendar

THE DAWN OF HISTORY

THE OLD STONE AGE IN EUROPE

MILLIONS and millions of years ago, when men first lived in Europe, the climate was very hot, as hot as it is now in the hottest parts of Africa and Asia.

We will call one of these early men Homo. He lived in a way very different from that in which men live to-day. He had a wife and children, but they had no house. Instead, they dwelt up in the trees and small caves, so as to be safely out of the way of the wild beasts who roamed the land. He did not always stay in the same place but moved about, staying wherever he could find food and water.

Homo had no neighbours, for in those days people did not live together in villages and cities. In fact, Homo was not pleased to see another man, because he took it for granted that he would be an enemy, and also he knew that the stranger would eat up the food Homo wanted for himself.

When he was hungry there were no shops to which his wife could go to buy food. Homo always had to find food for himself. In fact, he spent almost all his time searching for it, and unless he found it he starved. He knew all the trees on which nuts grew, and when he recognized one he was very pleased. He was delighted when he found some crab apples or sloes or wild cherries. He knew, too, all the berries that were good to eat, and he sometimes was able to steal the wild honey without the bees stinging him.

Sometimes Homo spent a morning beside the stream trying to catch a fish in his fingers, but he was not often successful, as he had no fishing rod to help him. At times, when he could get none of these foods, he pulled up roots and satisfied his hunger with them.

Homo knew that the flesh of animals was good to eat, as he had tasted it sometimes. He would have liked to kill the wild animals that were always chasing each other in the forest, but he had no weapons. Sometimes when he saw a little animal he took up a stone and threw it. After much practice his aim grew better, and he sometimes killed one.

He did not then cook the animal that he had killed, for he had no fire. He did not know what knives and forks were. He ate his meat holding it up in his fingers and picking the bones with his teeth.

Homo did not feel the need of a fire to warm him, for it was always very hot. For the same reason he did not need clothes. The hair on his body grew rather long, and that was his only covering.

Homo did not look like men of to-day. We do not know whether he was tall or short, but he had a receding chin, and he could not hold himself quite upright, but slunk along with bent shoulders and knees and head thrust forward.

He lived in great dread of the animals that roamed the forests. One of the fiercest of these was the sabre-toothed tiger, which had great

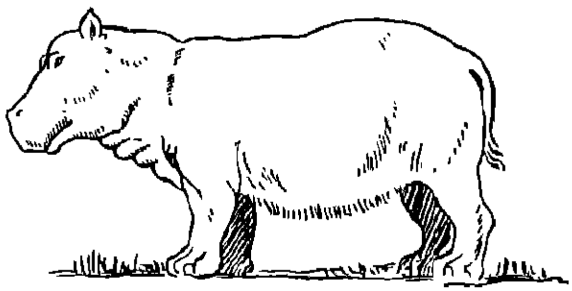


FIG. 10

Hippopotamus

tusks like short swords. There are no sabre-toothed tigers living to-day The hippopotamus, the smooth-coated elephant, and the rhinoceros dwelt in the woods and terrified Homo by their roarings.

When he heard or saw one of these ferocious beasts he ceased picking berries or whatever else he was doing, ran as fast as he could to the nearest tree, and swung himself into its branches with a sigh of relief that he was safe once again.

Homo lived in constant dread of these animals, especially at night, when they might come upon him without warning. So every night when it grew dark he climed up a tree or went into a cave and stayed there till it was light again.

Ignis, the Man who First Used Fire

We do not yet know when man first made fire, but it was very early, for Pekin Man had it.

This is a story of how men may perhaps have learnt about fire.

One night there was a terrible storm of thunder and lightning. The thunder claps succeeded each other with scarcely a break, and the lightning flashed in the sky so that it lit up the forest as though it were day. The sabre-toothed tigers, the cave bears, and all the other animals were quiet, and Ignis, the early man, and his wife and children were terrified.

Suddenly Ignis saw the lightning run down the trunk of a tree. The tree fell, the trunk and the branches ablaze. Ignis was so much afraid at this sight that he fled with his family, but not so far that he could not see the blaze.

He noticed that the fire gradually grew less, and, his curiosity getting the better of his fear, he crept near to the tree. His wife, meanwhile, climbed up another tree with her children. Now that Ignis had lost his great fear he rather liked the fire because it looked cheerful. He felt a strange heat on his body as though the sun were shining. He knew that it could not be the sun's rays because it was night. It must be the blazing tree.

As the blaze died down he was sorry, and wondered what he could do to keep it alive. He thought for a moment, and then decided to try to feed it. Then he fetched a few twigs that were lying on the ground near and put them on the fire. Great was his joy when he saw that the flames began to leap up again. Then as his twigs burnt away the flames of the fire grew less. Once again he brought twigs and mended the fire. Finally, he made up a good fire, and sat down beside it, though his wife called to him to climb the tree for safety.

Suddenly he leapt up and fled to the nearest tree. He heard Sabre-tooth in the distance. Sabre-tooth drew nearer, scenting a man, came fairly close up to the fire and then stalked away. Next came an elephant, but he lumbered off at sight of the fire. Then Ignis realized that he had spent the night on the ground and that no wild beasts had come near him till Sabre-tooth arrived. Never before had he spent a night in the open, for by night the wild beasts prowled and Ignis knew that he must keep safely out of their way.

All the next day Ignis spent beside the fire, feeding it with wood whenever it grew low. At first every time he heard a growl he climbed the nearest tree, but, having seen animal after animal afraid of the fire, he stayed on the ground next time Sabre-tooth came near, and found that while he was by the fire he was safe. Ignis' wife and children came to the fire, too.

When evening came Ignis suggested that they should lie down by the fire for the night. "The fire," he said, "will keep you safe from the wild beasts, and it will be much more comfortable to stretch yourselves on the ground and go to sleep than to lie curled up in the branches of a tree." They agreed to divide the night into half, one to watch that the fire did not go out while the other went to sleep.

Next day some other families came near the place where Ignis and his wife were. At first they were much frightened at the fire, as Ignis had been, but, seeing that no harm came to Ignis and his wife, they ventured nearer. When they discovered that the fire served to keep the wild beasts away they wanted to have a fire of their own.

For a long time no one could think how this could be managed. Then Ignis said, "Take a log of wood and place it in the fire." The log blazed merrily after a short time. Ignis then told them to carry this lighted torch with them wherever they went.

Each of the onlookers was supplied with a lighted brand, and each set off in his own direction. One quickly found that the log went out. Another, when he found that his log was not burning as brightly as before, held it downwards by good fortune, and found out that it burnt better so. When in course of time the log was nearly burnt out he put it down on the earth and lighted another from it.

Those whose brands went out went back to Ignis and lighted others, so that they might have fires wherever they went. Thus people for the first time had fires, but they did not yet know how to light a fire. They were thus very careful to keep the fire always burning, and while the men and women were busy hunting for food it was the business of the old people and the children to keep the fire alight.

Activities

Observation of the behaviour of the fire in the classroom or at home, and discussion of the many purposes for which we use fire may well follow. The life of Ignis also provides good material for miming and dramatization, red paper tied round sticks representing firebrands.

Flint, the Man who Made the First Tool and Weapon

For thousands of years men lived as Homo did, using stones they picked up as their only tool and weapon. We do not know what was the name of the first man who thought of sharpening a stone, but we will call him Flint.

Flint grew dissatisfied with the stones that he used, and he thought that he would get much better results if he had a pointed tool. So he looked for a big stone that was already something like the shape he wanted, and when he had found it he hit it with another. Nothing happened. Then by chance he took up a piece of a particular kind of stone which is called flint. Once again he squatted down, took up a large stone that he used as a hammer, and with it hit the flint stone he had just picked up. He was delighted and surprised when he saw that he had chipped off large flakes from the piece of flint. Never before had he found a stone that would flake in this way. He went on working until the edge on the flint was sharper than any edge he had ever seen before. We, perhaps, should not call it very sharp, for its edge was wavy and uneven, but Flint was well satisfied. He left the lower end of the flint round and unchipped, so that he could hold it comfortably in his hand.

Flint found many uses for this tool that he had made. When he wanted to cut up raw meat he found it better than any stone he had used before. He used it as a scraper, too, when he wished to separate the skin from the flesh of the animals that he managed to catch. With its help he sharpened the ends of sticks that would serve him as spears.

One day it occurred to him to throw his flint at a small animal that was hurrying by. It chanced that the sharpened end hit the animal, which was killed at once. Flint had found a new use for his tool. It was a weapon for killing animals as well as a tool for cutting. Flint watched very carefully where the flint went

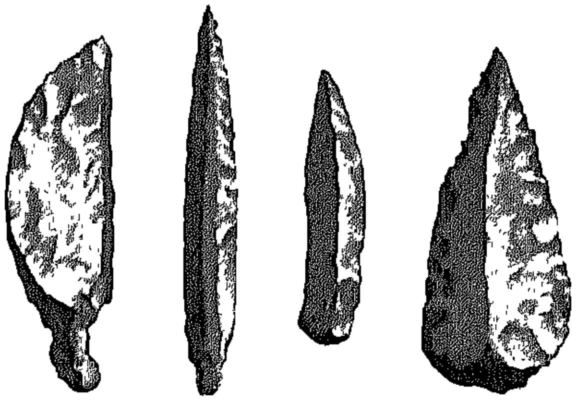


FIG. 11

Old Stone Age Tools

when he threw it at an animal, so that he could find it again. It took him much time and trouble to sharpen the flint-stone, and so he was careful not to lose it.

Other people saw this tool and weapon that Flint had made, and they wanted flints like it. They, therefore, stood round him while he sat down, took a heavy hammer stone and with it chipped off flakes until another flint-stone was the shape that he required. Then these other men found similar stones and made flints for themselves, until at length every one learnt to make flints.

For many thousands of years men made their tools and weapons out of flint-stone, and with practice they learnt to make them with better edges, and with less trouble to themselves. Men in those days chose to live in those parts of the

country where they could find flint. Flints are to be found in chalk.

Note. The teacher should take a piece of flint to show the children. If the children live in chalk country let them look for flint-stones. Wherever they live let them look for stones that from their shape might serve as tools and weapons, and make spears by sharpening the ends of sticks.

How Men Won the Caves for Homes

For some time men lived on the ground without houses, but defended from the wild beasts by the big fires that they kept up.

The climate during this time changed more than once, but finally there came a terribly cold time, and men began to feel the need of some permanent shelter from the rain, the wind, and the snow.

Let us imagine at this time a clan, all related to each other, and who obeyed their chief, Nean. They had suffered much from the cold, the wind, and the snow. Nean noticed that there was a large cave near at hand that was inhabited by cave bears and cave lions. He called to him all the men of the clan, and suggested to them that they should drive the wild animals out of the cave and take it for themselves as a shelter from the weather. They shook their heads, for they did not see how this was possible. They dared not attack the wild beasts, for, though they had beautifully made stone flints, they knew that they would be little use against such ferocious beasts, and that in the strife they were far more likely to be killed than to kill the wild beasts.

After much thought Nean said, "I know what we will do. Let us each take up a burning brand from the fire, and, carrying these, enter the cave. The bears and lions will be so terrified that they will flee outside without harming us."

Some were still afraid to make the attempt, but the rest did as Nean suggested, and all fell out as he had planned

Great was the rejoicing of the tribe, and the women praised the heroes as they came with their children into the shelter.

One man, more cautious than the rest, said, "We have driven out the wild beasts from the cave, but they will be sure to return. What shall we do then?"

Nean thought a moment and then answered, "Let us build a great fire at the entrance of the cave. That will scare away the bears and the lions, and we shall have the cave for our home."

This was done, and though the inhabitants of the cave often saw the wild beasts prowling at some distance from the fire, and though they heard their growls, they were safe inside the cave.

Note. Let the class act the story of Nean and his clan winning the cave for their home.

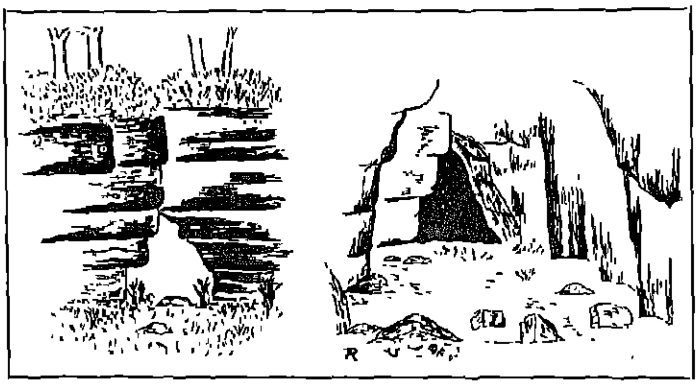


FIG. 12

Outside and Inside an Old Stone Age Cave

The refuse dumps (R) have proved valuable sources of information concerning the daily lives of these prehistoric men

Daily Life of an Early Cave Man

It is morning. In front of the cave stands the leader of the clan, Nean. He is far from beautiful to look at, for he cannot stand upright as we do, since his head is poked forward. His knees, too, are bent forward, and he is not tall. His forehead is low and sloping, projecting forward in huge brow ridges. He has a well shaped nose but a long projecting upper lip, and a very more quickly than Flint, and they have a keener edge.

When Nean is tired of this occupation he calls to his sons, and goes to the openings of the other caves near, calling to the men to go out hunting. Ignis and his family and friends had been afraid of the wild beasts, but Nean is less frightened because he knows that fire will scare them and that he can trap them. The men come out of the caves armed with spears tipped with

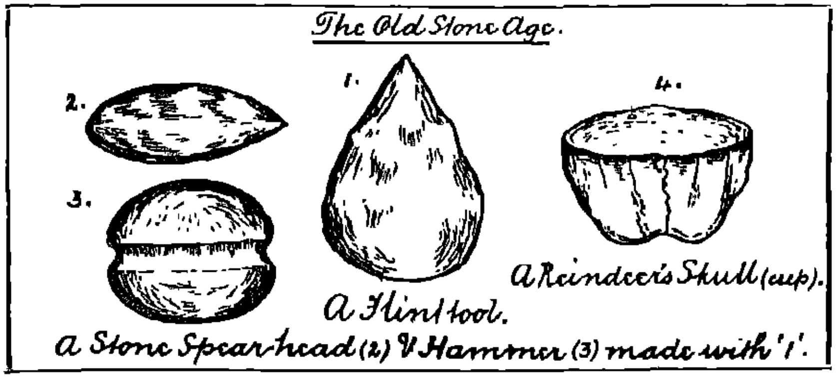


FIG. 13

receding chin. He is wearing a skin to keep him warm.

He sits down and busies himself in making a flint weapon. He seems to us, as we watch him, to be clumsy at his work, because his thumb and finger do not work together perfectly as ours do, but he is working at his flint-making far more intelligently than did Flint, the first maker of stone weapons.

Flint took a piece of flint and chipped flakes off it until it was the right shape. Nean knocks his flint so cleverly that he is able to fashion a weapon out of many of the flakes that he chips off. He strikes a carefully directed blow with his hammer stone. Many chips fly off. He looks through these, and puts on one side for further attention all those which are roughly the shape he requires. He takes each of these in turn and chips them on the outer side until they have a good edge. He does not need to do anything to the inner side of the flake for that is quite smooth. Flint-stone always chips in that way. In this way Nean is able to make his tools far

flint, and with daggers made of reindeer horn. The animals that Nean and his clan go out to hunt are very different from the animals which inhabited Europe in the days of the first men. At that time the climate was warm, and the animals who could live best in tropical forests

FIG. 14
Hyena

were roaming the earth and frightening men, sabre-toothed tigers, elephants, the hippopotamus, and the rhinoceros.

By the time of Nean these animals had retreated to the south, for the weather in Europe

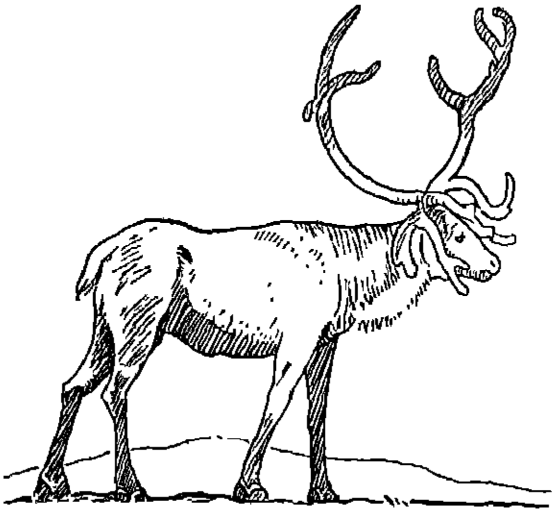


FIG. 15
Reindeer

was too cold for them, and in their place the forests were inhabited by animals who enjoyed the cold weather. The cave bear, the cave lion, and the cave hyena roamed at large. The wild boar and the wild horse, herds of bison and reindeer were always on the move. Instead of the smooth-coated rhinoceros was the woolly rhinoceros, a clumsy creature with one cruel looking tusk growing upright on its snout, and a shorter one on its forehead, and a thick shaggy coat as a protection from the cold.

Nean and the hunters were specially pleased if, in their hunting, they were able to trap a mammoth. This was a huge creature bigger than an elephant, covered with reddish coloured hair, with immense tusks of ivory on either side of its trunk, a curiously domed head, and feet rather like immense mushrooms. It browsed on the leaves of thyme and crowfoot, which seem very small for such a huge creature to eat.

Nean and the other hunters go round to visit the traps that they had made the day before. Yesterday the hunters dug several great holes in the ground and in them, sticking out from the sides, they had set sharply pointed branches. Then they covered the top of the hole with a layer of twigs, and above that a smooth layer of turf, so that the unsuspecting animal would put his fore feet on the turf and twigs, pitch into the hole, and be transfixed on the pointed poles.

In one of the traps Nean and the hunters, to their great delight, find a mammoth. The animal is far too big for them to carry home to the cave whole, so they cut off the best joints with their flint knives and reluctantly leave the rest for the animals and birds to devour.

Meanwhile the women, who are much like the men in appearance, busy themselves in and near the caves. They spend the day preparing the skin of a wild animal which the hunters had recently brought in. First they find a smooth spot outside the cave and there they stretch the skin. Then they make little slits all round the edge and drive little pegs of wood into them, so that the skin is stretched out firmly on the ground.

Then they take their flint scrapers and scrape off all the remaining bits of flesh on the skin. As they do this they are very careful not to spoil the skin by cutting holes into it.

When they have made the skin smooth they rub fat into it so as to make it soft. Then they

FIG. 16
Bison

dry it in the sun. Finally, it is stored away in the cave till one of the family needs a new dress.

The women keep the children who are old enough to work busily employed in fetching

wood to feed the fire, and in carrying water from the stream that flows some little distance away in roughly hollowed vessels made of wood.

At last it is evening and the hunters return, guided home partly by the lights of the blazing fires in front of each of the caves. Very pleased are the women and the children to see the hunters, for they bring with them food for some days.

The women put down as many joints as are required beside the fire, for very early on men had learnt that roasted meat is much more appetising than raw meat. They have, of course, no oven to use, nor are there any dishes on which to put the meat when it is cooked.

When the meal is ready the whole family gathers round the fire inside the cave for a feast They sit on their haunches, pick up the meat with their hands, and pull it to pieces with their hands and teeth. They have no plates, nor forks. Anything that they do not like or that they cannot eat they throw down on the floor of the cave.

As they sit round the fire after the feast Nean tells the story of the hunt and of the dangers of the day. He has not many words with which to tell his story, but he ekes them out with gestures. The rest sit round interested, making comments every now and again. So arises the art of story telling.

Nean's Death and Burial

One day, when Nean was an old man, he lay down and every one thought that he was asleep. When they were all ready for the feast his wife went to wake him, but she found that he was dead.

She wept, and so did the children. Then they dried their eyes and set to work to provide him with all the things that he would need in his new life. They dug a shallow grave in their cave and laid his body there. Beside him they laid joints of meat so that he should feel no hunger on his long journey to the next world. They thought that he would be sure to hunt in the next world in the same way that he hunted in this life, so they put his best weapon near his hand and many more tools with it. Under his head they placed a pile of flints to make a kind of pillow. Perhaps they thought he would need flint to make himself more weapons.

These Cave Dwellers were the first people to bury their dead with a care that showed that

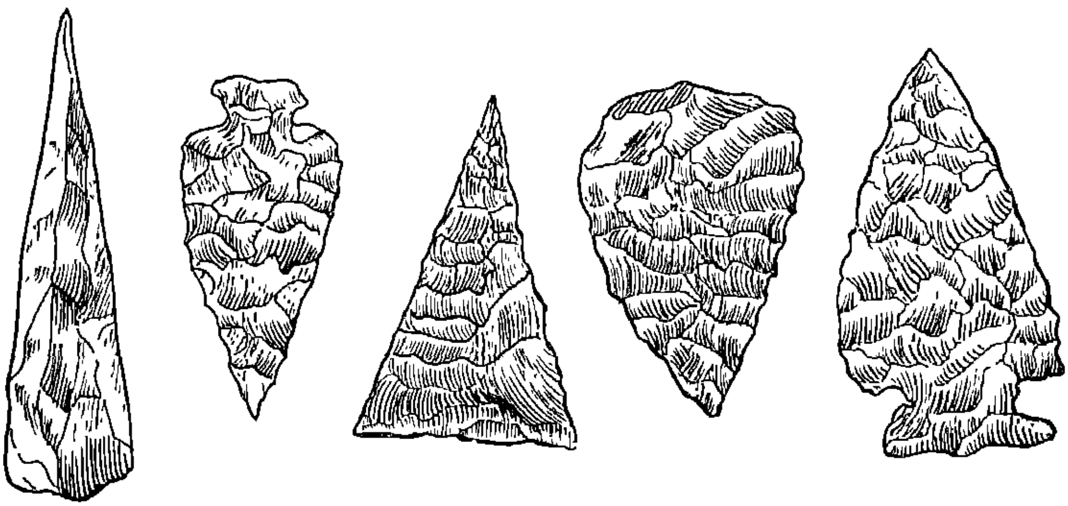


FIG. 17

An Early Cave Man's Flint Tools

This may easily be reproduced on the blackboard, and the children can then discuss the various shapes and their usefulness.

they thought that their dead friends were alive in some other world. It is very fortunate for us that they had this belief, because it is from these burials and from what people have found in caves that we are able to learn how the cave men lived.

Activities

Let the children visit a cave, if there is one in the neighbourhood. Let them observe the roof, the floor, and then discuss its suitability as a dwelling. This will lead to the idea that men would in course of time want a better home.

If practicable, let the children, in their spare time, make a cave with big stones in the playground. Outside the cave let them represent the fire and the rubbish heap.

Let the children make a model of the cave dwellers' surroundings in the large sand tray. The cave should be built up of large stones. Dried moss will represent grass, a groove covered with silver paper the stream, and small pebbles weapons. Let one of the children cut out the shape of an animal's skin from an old glove, and fasten it down with twigs to represent the skin stretched to dry. Other children might model in plasticine the animals that the cave men hunted, while another might dress a doll in skins to represent Nean.

The Later Cave Men

Centuries passed, and then a new type of man appeared in Europe. We will call one of these men Magnon. He was very tall, about 6 ft. high, and very well built. He was able to stand upright, and his thumb and finger worked together as ours do. He was beautiful to look at, and was quite without the overhanging eyebrows, the broad nose, and the receding chin and forehead that had made Nean and the men of his time so ugly.

The weather was still cold, as we know, because Magnon hunted the woolly rhinoceros and the mammoth, creatures which dwelt only in a cold climate. It was not so rainy and unpleasant as it had been at the time when Nean was living.

Magnon was a very skilful hunter, making for himself better and more varied weapons than any men had made before. He made beautiful spears that he could throw at the wild horses. First he cut down a branch of ash or willow and then rubbed it across a notched flint till it was smooth and round. Then, to make sure that it was perfectly straight and true, he heated it slowly at the fire and then passed it backwards and forwards through a round hole cut in a piece of reindeer horn. Then he took a spear head that he had already made in flint, fitted it into the split end of the shaft, and bound the two together with a leather thong.

Magnon used his spear to bring down the

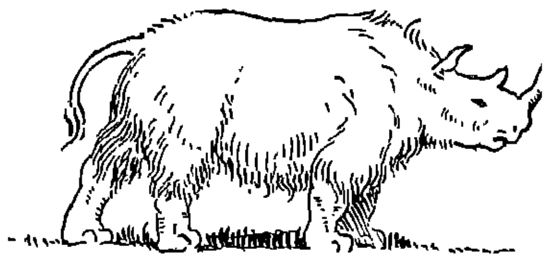


FIG. 18
Woolly Rhinoceros

wild horse. He and his family were very fond of horseflesh to eat. It had not occurred to them to try to tame the horse and make it carry burdens.

Magnon invented the bow and arrow. One day he had made a small spear. In an idle mood he tied a leather thong to a pliant piece of ash. He stretched the thong away from the ash stick, and finding that the distance in the middle of the thong away from the ash stick was just as long as his little spear he fitted in the spear. Then he released the spear, which was really a big arrow, and the spear sped away farther than Magnon had ever been able to throw any weapon. Magnon was greatly delighted with his invention, and he made for himself a number of bows and a supply of arrows. When the other hunters saw this new weapon that Magnon had invented they begged him to show them how it was made. He agreed to this, and from that time the men had better success in their hunting.

Magnon was also a great fisher. He was the

first man to make a harpoon out of a piece of bone. Before he thought of his new plan men used to throw spears at fish, and must often have been disappointed because the fish that they had speared got safely away after all. It occurred to Magnon that if he made notches in the side of the bone the barbs would hold the fish after it had been speared. He was very gratified when he discovered that he was quite right, and that if he was able to spear the fish it was unable to escape. Later he thought that

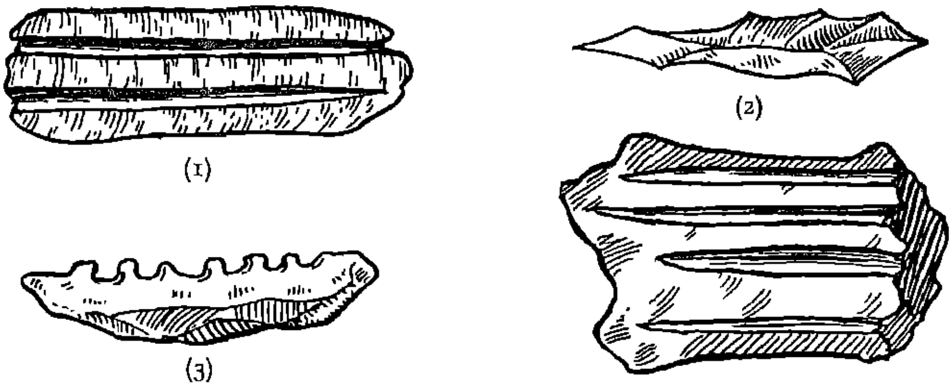


FIG. 19 (4)

Earlier Method of Making Needles

(1) *Bone from which splinters were cut* (2) *Sharp flint tool* (3) *Scraper* (4) *Stone polisher*

his weapon would be more certain to retain the fish if he made barbs down both sides.

He was still not quite satisfied for he often lost his weapon when he was trying to spear a fish or an animal, and this was a serious matter because it took Magnon a long time to make the weapons he needed. One day he thought of the plan of making a spear with a socket. To this he tied the barbed head loosely, instead of binding the head to the shaft. This weapon, a barbed head loosely attached to a shaft, is what is known as a harpoon.

Magnon in his fishing felt the need for a boat. He noticed a log of wood floating on the stream, and he pondered over what he had seen. Why did wood float on the water, while stone at once sank to the bottom of the river? One day one of these logs drifted to the river bank, and Magnon made up his mind to find out whether, if he sat on the log in the water he would sink. He knew that the water beside the bank was shallow so that he would be in no danger. He was triumphant when he found that he could ride the water on his log. Then he moved his position slightly, and fell into the river amid the laughter of the onlookers.

Nothing daunted, he tried many more times, and gradually learnt so to balance himself that he rarely fell over.

Next he tried to guide his rough boat by means of his hands. He found this uncomfortable, and he often fell into the river. Then one day he got the idea of making a rough paddle of wood to serve as an extension of his arms, and he found that this was much more convenient.

One day he had an extra heavy load that he wanted to carry to the other side of the river. It occurred to him that if he lashed two logs together, fastening them securely with leather thongs, he would make a bigger boat. Great was his delight when he discovered that this new boat would carry his heavy load, and also that it was less liable to capsize than the single log that he had used before. After this he and his friends always lashed two logs together to make a boat.

Magnon and his wife Aurig were very fond of pretty things, and they made for themselves ornaments of various kinds. They specially liked to wear shells because they were pretty, and perhaps because they believed that the shells would bring them good luck.

Aurig was very clever at making jewellery of

this kind. She took a sharply pointed flint and pierced small holes in the shells and then threaded them to make necklaces and armlets, leg bands, and coronets. Sometimes she fastened shells on to the skin dresses that she made for her husband Magnon and her children.

When she could not get shells she used deer's teeth, first making patterns on them, and sometimes she used fish-bones. She was not satisfied with making a simple necklace of a string of beads, but she worked the beads that she had made and the shells into beautiful patterns.

Sometimes she made pendants by threading something believed to be lucky on to a thong of

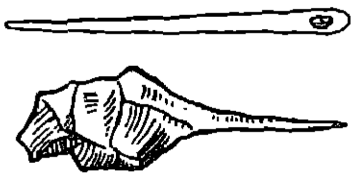


FIG. 20

Needle with Eye and Flint Borer

hide. Bangles she contrived by cutting a ring out of the hollow part of an elephant's tusk, and then decorating it. Beads, too, she carved out of a mammoth's tusk, carving them with her flint knife.

It was at this time that women first began to sew, and Aurig was very skilful with her needle. Nean and the early cave dwellers had been contented to fling the skins of a large animal round them, but these later cave men wanted clothes that would fit them better. Of course, Aurig had no reels of cotton, but she used the sinews of wild animals killed by Magnon or else narrow thongs of leather.

When Magnon wanted to make a needle for Aurig he cut a splinter of bone out of a reindeer horn, by cutting a groove on each side with one of his flint graving tools. Then he took a scraper and shaved down the splinter to the right shape and thickness. Next he polished it. With this needle Aurig pierced the skin and then she pulled the sinew through the holes with her fingers.

One day it occurred to her that if she had a sharp point at one end of her needle and a blunt barb at the other (like a crochet hook), she could pierce the skin with the point and use the hooked end like a crochet hook to pull the sinew through. She asked Magnon to make her next needle in this way, and thanked him very much when she found out that she could sew far more quickly with this new kind of needle.

Then some time later she suggested to Magnon that he should bore an eye with a flint borer through the head of the needle. There was no further need for the barbed end like a crochet hook, for this new needle would carry the thread through at the same time that it pierced the skin.

Aurig was delighted with this quick device for sewing, and she put all her needles into the needle case that Magnon had made for her by stopping the end of a hollow bone.

With these quite modern needles she sewed the skins together, and put on buttons to fasten up the openings.

Aurig was also very skilful in making baskets, which she found very useful for carrying berries. For these she gathered twigs from the willow trees that grew beside the streams. These twigs are called osiers or withies. When she had brought them home to her cave, she chose out the stronger ones and tied them with sinews in position at the centre of the base of the basket, and then bent them upwards into the right shape. Then she chose a thinner, more flexible twig and, beginning at the base, she passed it alternately over and under (in front and behind) the framework that she had made. When this osier was neatly woven in she took another and wove it over and under the framework in the same way.

Note. Let children make for themselves bows and arrows and try to shoot with them. Let them make a tiny raft using twigs and string. Let them make a needle out of a fish-bone and use it to sew leather, from an old kid glove, to dress a doll.

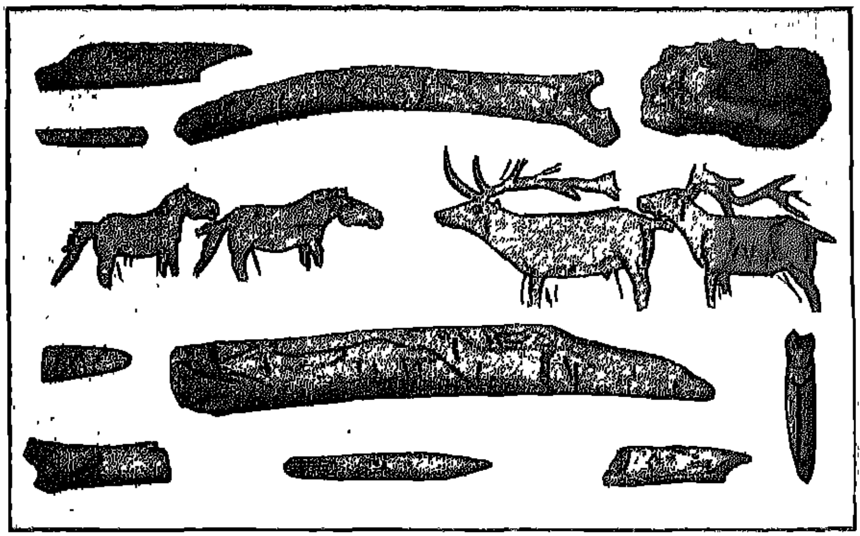
The First Artists

These later cave dwellers were the first artists. They were very clever at making their pencils or graving tools out of flint. They had many different kinds of pencils, strong thick ones for

drawing on the cave walls, and light fine ones for engraving on bone or horn.

These artists drew on the walls of the caves the animals that they saw when out hunting, bulls, stags, deer, and bison. Hunters, of course, have to watch their quarry very carefully if they are to catch and kill it, and thus these artists knew very clearly what the animal they

After long practice these artists became so skilful that they began to use colour and paint pictures. When they painted a mammoth it seemed as if it was alive from the tip of its trunk to the end of its tufted tail. The bison and the boar looked as though they were just about to charge, the reindeer and the red deer appeared to be moving in a slow easy canter. Many



By courtesy of *The British Museum*

FIG. 21

Prehistoric Drawings

were trying to draw looked like At first, however, they found it very difficult to draw what they saw. They drew the animals from the side view so that only two of the four legs showed, for they experienced great difficulty in making the legs look lifelike. At first they drew an outline only, but as they progressed they put in a dot for an eye and a few lines to represent the longest fur.

These cave artists were not satisfied with portraying the animals standing still. They longed to draw them in motion, but this presented the most perplexing problems. How should they show the movement of the legs? One day a brilliant idea occurred to one of them. He drew the same leg two or three times in different positions, and so gave to the legs a fan-like effect.

modern artists would be glad if they could represent animals as well as these cave artists.

An artist got his red and yellow colour from oxide of iron and black from manganese ore. He ground his colours with a pestle in a stone mortar. When he had ground the reds, browns, blacks, and yellows, he put them into little tubes made of reindeer horn.

When he was about to paint his picture he mixed his colours on a palette made of the shoulder blade of an animal. Then he engraved an outline and over this smeared the soft colours until they made a soft paste, blending them well together until he had made the body look round and not flat. Then he took a brush which he had made of animals' bristles and put in the details. He made deep shadows so that his picture should stand out clearly, and took out

the colours when he wanted to put in a high light

The artist had for his canvas the walls of a cave which was so dark that he always had to paint by candlelight To make his candle he

FIG. 22

A Cave Man's "Candle"

first hollowed out a stone about as large as his hand. Then he gathered moss which he pounded to powder and mixed it with the fat of a cave bear. This is the kind of candle that the Eskimos use to-day. He lighted his candle with a twig from the fire and then, holding his lighted candle in his left hand, he painted with his right.

Caves with walls adorned with these wonderful paintings are to be found in various parts of France and Spain. There are three unexpected features about these paintings. One is that often one animal is drawn over part of another, and some are drawn at an angle from the ground and some upside down. It would appear, therefore, that the paintings were not made with the view of decorating the caves.

The second strange feature about the paintings is that they are rarely found near the mouth of the cave, but almost always far in and very often in almost inaccessible spots. To paint the pictures the artists must have scrambled over almost impassable obstacles, and have risked their lives in climbing to great heights.

A third characteristic of some of the paintings is that the animals have a heart painted in the right spot in the body, and arrows leading to it.

All these facts taken together led modern people to suppose that artists drew the animals as an aid to the hunters, and this idea is borne out by the discovery made inside a cave at Montespan. On the floor are thirty clay models of horses, three huge lionesses, and in the centre a life-size model of a bear with a young bear's head in his claws. All over the models are the marks of spears. Hunters came here to stab these models of bears, hoping that in this way, and perhaps by the aid of magic words spoken by a magician, they would be successful in their bear hunts.

The same idea of aiding their hunting may have been in their minds when they engraved

FIG. 23

A Cave Man's Drawing of a Mammoth

fish on a harpoon or deer on the handle of their dart throwers.

The cave artists made a few models of thin men and very fat women, but they are very poor. No trouble was taken to make the faces at all life like, and this was perhaps omitted in case some enemy should get possession of the statuette and use it to bring harm to the original.

THE NEW STONE AGE IN BRITAIN

At the time when the cave artists were drawing their marvellous animals the climate of Europe began to change. Never again was it very hot as it had been at the time of the earliest men, neither was it ever so cold as it had been when men first took to living in caves, nor did it again vary so much as it had done during the thousands of years that men had dwelt in caves.

At the time when the New Stone Age men first came to Britain the climate became temperate, that is, much the same as it is to-day.

With the change of climate there came a change in the kinds of animals who dwelt in Britain. Some died out, while the reindeer and others went farther north to the type of climate that they preferred. New animals took their

place: the wolf, the brown bear, the wild boar, the fox, the badger, and the beaver.

Britain at this time was covered at all the lower levels with dense forests. Willows, elders, and birches grew in the valleys which were marshy. On the drier soils oaks, ashes, yews, and Scotch firs flourished, with an undergrowth of dense hazel thickets. Bilberries, cranberries, and heather covered the windy moors. In

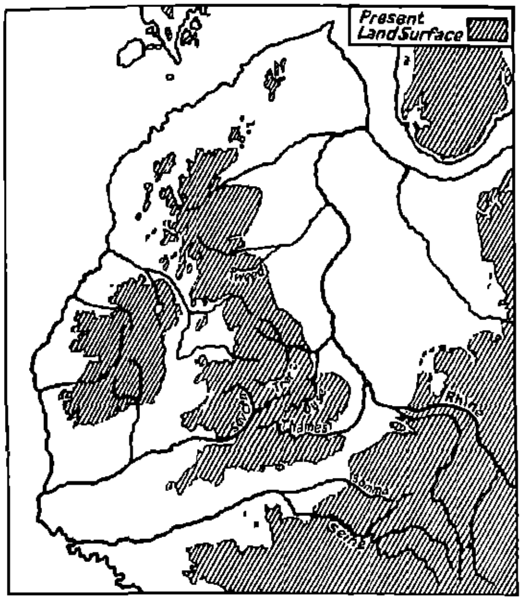


FIG. 24

Map Showing Probable Coastline of N.W. Europe in the Old Stone Age

the Downland valleys grew the yews and junipers, but the tops of the Downs were then as now covered with short grass only

To Britain at this time came a new race of people whom we call the men of the New Stone Age. They were dark-skinned, lithe, and wiry, and of short stature. No one knows with certainty where they came from originally, though we know that they came here from Asia, some crossing to Africa and then reaching the British Isles from Spain, Italy, and France and some coming across Europe. The sea had already invaded the land and the English Channel separated England and France, and the Irish Sea came between Great Britain and Ireland.

The New Stone Age men made their settlements on the high land in Britain, on the North and South Downs, the Chilterns, the East Anglian Heights, the Cotswolds, the Dorset

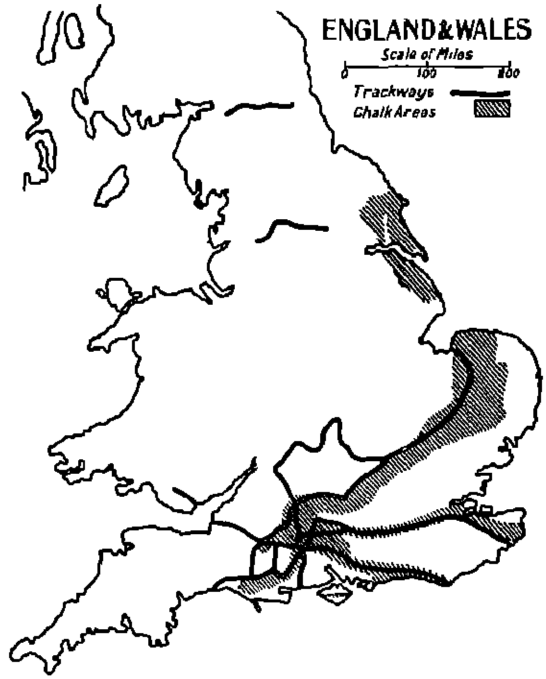


FIG. 25

Map Showing Chalk Lands of Britain and New Stone Age Trackways

Heights, the Mendips, the York Moors and Wolds, Dartmoor, Exmoor, and in some parts of the Pennines and Wales

The New Stone Age people made their camps on the higher land because wild beasts abounded in the forests below. The position also afforded a better defence against enemies

The camps, or forts, which they made on these heights are all connected by trackways, which have been called "The Green Roads of England." One of these, the Ridgeway, came from the Fenland along the Chilterns to the White Horse and the Marlborough Downs The Harroway came from Cornwall through

Hampshire to the Thames Estuary The Pilgrims' Way along the southern slopes of the North Downs was a third. These trackways meet at Stonehenge on Salisbury Plain, the

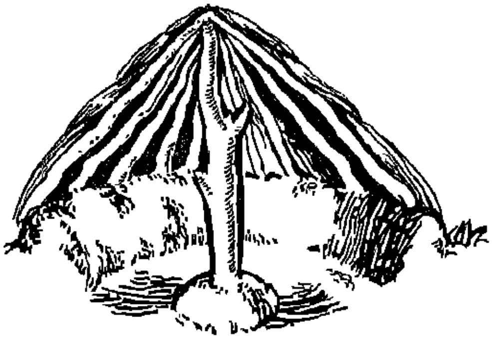


FIG. 26
Interior of New Stone Age Hut

district which in the New Stone Age was the most important part of Britain.

Perhaps the most famous of all these forts is Maiden Castle near Dorchester in Dorset. It stands four hundred and thirty feet above sea level on the summit of a large Down. Its defences were later enlarged by the Iron Age men to a circumference of nearly two miles. The tops of the Iron Age ramparts still stand some fifty feet above the ditches. In parts most open to attack, the Iron Age ramparts stand three, four, or five deep, one behind and above the other.

The New Stone Age men who made the smaller forts with an enormous amount of hard work, patience, and foresight made them largely to keep cattle from straying. The forts were not then places of refuge to which men retired when threatened by their enemies. They were villages in which men spent their lives. These fortified villages were, therefore, like the walled market towns of the Middle Ages, communities which in unsettled times were glad of the protection of ditch and rampart.

Some of the camps were manufacturing villages, such as the fortified camp at Cissbury in Sussex. Others seem to have been centres for the storing and selling of the grain that was grown on the terraces below the camps.

A New Stone Age Fort

Let us pay a visit to one of these forts while it is being built.

The chief of the tribe walks in front of the others looking for the most suitable spot on which to erect it At length he comes to the highest point of the chalk Down. He notes that on one side the down drops sheer to the plain below. He consults the older men of the tribe and they decide that this is an ideal position for a fort, since they are defended on the one side against their enemies by the nature of the ground, and they can see their enemies in the distance whichever way they come.

The chief gives orders that each man shall first make himself a hut.

Among the men is Bara, who quickly sets to work. He takes his spade, made of the shoulder blade of an ox, and begins to dig a circular hole about four feet deep and ten or twelve feet across As he digs he throws up the earth round the edge of the hole. His wife, Yama, and the older children take smaller spades and beat the earth which Bara throws up until it makes a hard wall rising two or three feet above the level of the soil. Yama is careful to leave a gap for an entrance.

As soon as this is finished Bara goes to the

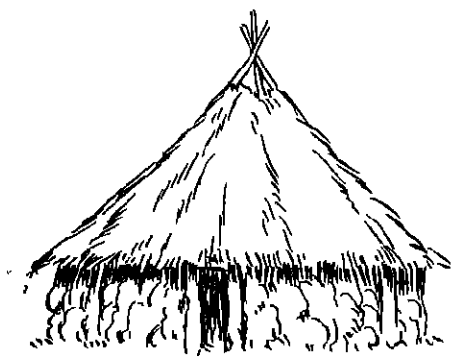


FIG. 27
New Stone Age Hut

nearest spinney to find a suitable young sapling to make the rooftree of his little hut. He chooses one which begins to branch at the height that he requires and uproots it. He carries it back to the pit dwelling he has made and embeds it

in the centre of the floor of the hut, using the branches for the framework of the roof.

Meanwhile Yama and the children bring in osiers, and Yama roughly weaves the roof in something the same way that Aurig wove the baskets. In the cracks they wedge moss to keep out the draught.

Bara and Yama were glad when they had finished making for themselves a pit dwelling, and when they sat round the fire at night Bara told Yama that he had seen other kinds of houses in those parts of the country in which stone was abundant and wood less plentiful. They were round buildings of stone laid without mortar or cement. Each course of stone seemed on the inside slightly to overhang the one just below it. In this way the space within the hut grew smaller, and a single stone completed the top of the building. There was a small doorway into the house which was closed by the placing of a stone in it. These were called Beehive Huts.

When each family had made a pit dwelling the chief ordered that a fortification should be made encircling the top of the down and enclosing within it all the pit dwellings. Again the men got out their shovels and their picks made out of antlers, and with these they dug a deep ditch round the camp. They carried the earth they dug out in baskets to make a rampart above the ditch. They left gaps in ditch and rampart, to act as bridges for coming and going.

This task kept them busy for many months, but when at last it was finished the chief and his tribe felt their cattle were safe.

Handwork

1. *A Hill Fort* Model in clay or damp sand a representation of a hill with a fairly flat top Round the brow and following the contour of the hill throw up a rough rampart of sand or clay. Inside the ditch and on the top of the hill represent a number of pit dwellings

2. *A Pit Dwelling.* Make on the modelling board a thick slab of rather hard clay. Dig out of it a circular hole of the required diameter Secure a rigid twig with a fork at one end, and, after sharpening the other end, wedge it securely into a hole in a bit of clay left in the middle of the floor of the hut. Place a hearthstone near the central pole. Place lengths of twigs at suitable intervals stretching from the clay to the fork of the upright. Weave in and out some pliable twigs or rushes and daub over with soft clay.

3. *Beehive Hut.* Build a beehive hut with bricks.

The First Farmers

Bara, the New Stone Age man who dwelt in the hill fort, was one of the first farmers. Since he had horses, cattle, sheep, goats, and pigs he was not dependent, as the Cave Men had been, on hunting to provide himself and his family with food, though he sometimes went out hunting so that he need not kill so many of his flocks and herds for food. The tending of these animals made Bara very busy. He had to milk the cows and the goats, and to see that none of them got ill. The cattle, too, soon ate up all the grass near the fort, and then Bara had to find some place where there was enough food for them.

Bara had a tame dog to help him. One day he had found a motherless puppy, and, thinking that its funny ways might amuse his little son in the pit dwelling, he took it home. When the puppy was young it often pulled things to pieces in fun, and Bara was angry with it, but as it grew older he found it very useful. When strangers were near the dog barked and warned Bara of their presence, and thus Bara had time to pick up his stone axe if an enemy was prowling round the fort When Bara went out hunting he always took his dog with him, for it proved useful in scenting out where the animals were, and ran them down and retrieved them when they were killed After much care Bara trained his dog to shepherd the sheep.

Bara spent part of his time in growing crops. In the early spring he broke up the soil with a pointed digging stick. Sometimes he found that he must dig the soil and for this he used a pick of flint or an antler of the red deer, and then digged with the flat broad shoulder blade of an ox.

When the ground was prepared he took his seed. He had so little of it that he did not scatter

it broadcast but put each seed in carefully. Then he left it for a while until the corn began to shoot up. Then he took a hoe and weeded out the weeds. Anxiously he watched the corn grow,

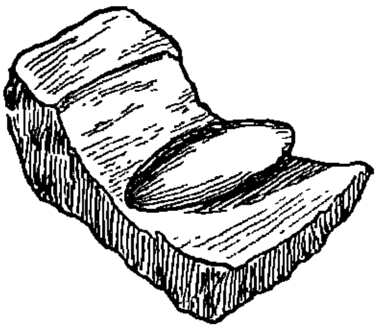


FIG. 28
Grinding Stone and Muller

for he knew that if he had a poor crop he and his wife Yama would be short of bread in the winter.

Then at harvest time he took a sickle made of flint, chipped to a slight curve, and about 8 in. long. With his left hand he took a handful of corn stalks and cut them off just below the ears. He continued to do this till all his harvest was reaped.

Later, on a windy day he carried his corn to an open-air threshing floor. There he beat the grain out of the husks with pliable green branches. Then, using his bone shovel, he threw the husks and the grain into the air The wind carried away the husk, and the heavier grain fell on to the threshing floor. Then he and Yama stored it away in earthenware pots until it was required for food or for seed when the next spring came.

Bara sowed his corn year after year in the same spot, and he noticed that the crops got poorer. One year, for some reason, he had to put in the seed in a fresh place He was astonished to find that he had a far better crop that year. When this had happened a number of times he reasoned that the better crop was not due to the weather or to chance. From that time forward he sowed his seed in a different place in two succeeding years.

Bara and the other farmers used the slope of the hill fort for growing their crops. With the help of their spades they digged the slope into terraces, and on them sowed their seed.

Miming

As the teacher tells the story let individual children come out to act in dumb show what Bara did. Suggestions for developing the ability of the children in this will be found in Volume I, page 267.

The First Bakers and Potters

Yama, Bara's wife, and the other women of the New Stone Age were far more busy than any women had ever been before, for they had all the tasks which the earlier women had had to perform, and in addition they had many extra things to do.

One of Yama's tasks was to grind into flour the wheat which Bara had grown. She placed the grain in the hollow of a saddle-backed quern and then rolled the upper stone to and fro until the corn became flour. Some of the women in the hill fort had a pot quern which was like a modern pestle and mortar, and this was more convenient. Often little bits of the stone of the quern were broken off and found their way into the flour.

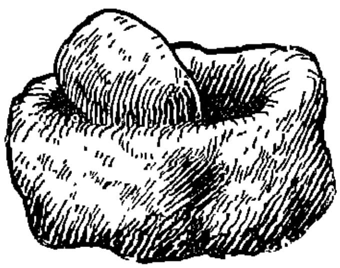


FIG. 29
A Pot Quern

Bara's and Yama's teeth were early worn away by the bits of stone they had in their bread

With the flour Yama made bread She had no yeast, nor anything else to make her bread rise, so that it probably tasted something like ship's biscuits. When she had made the bread she took it to her cooking hearth, which was just outside the hut. Yama did not think it safe to have her fire for cooking inside the pit

dwelling for fear the roof which was made of wood should catch fire Yama cooked in a little pit in which was a large stone When she had something ready to cook she raked the ashes of the fire to one side, put down the meat or the bread into the pit, covered it over, and then the heat of the stones turned the pit into an oven and cooked the meat or the bread.

Yama was very clever at making pottery. The women of the Old Stone Age had not known how to do this. First Yama collected clay from the river banks, and sand. She mixed equal proportions of the two together, and made long rolls of the clay. One or two of these she formed

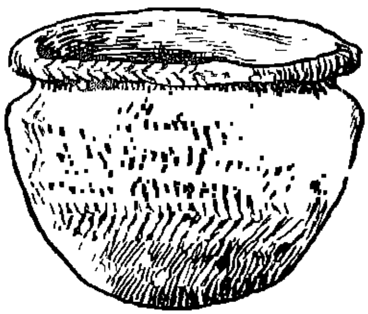


FIG. 30
A Neolithic Bowl

into a collar shape and, with one hand inside and with the other outside, she gradually modelled into shape the top half of the pot, more clay being added when needed in rolls.

She left the half pot to dry in the sun for some hours. Then she placed the top half upside down on its rim and added clay to form the bottom half, one hand shaping inside the pot and one out, until there was room for but one finger. Then Yama closed the hole and the pot was finished, except for the decoration. Yama ornamented her pots with lines arranged in herring-bone fashion, making the marks sometimes with her finger nail and sometimes with a stick while the clay was still damp

After Yama had left the pots to harden for a few hours she placed them mouth downwards on the ground, and made a bonfire of brushwood all round them; when this had burnt the pots were hardened and ready for use. The fire made them black or brown in colour.

Yama used some of these basins for cooking, and as they had no handles she had difficulty in taking them off the fire. Yama thought of a way to make them more useful. She made a hollow moulding between the lip and the shoulder, and when she went to take a pot off the fire she took a pliable green twig, wound it round the moulding, and took the pot off the fire without burning her hand. The first pots Yama made had a rounded bottom, and to make them stand up she put them in hollows in the ground. Later she found out how to make pots with flat bottoms which would stand up by themselves.

Yama found more and more uses for the pots that she made. In them she fetched and stored water and milk. Others she used to heat water on the fire and to boil meat. This way of cooking meat was new. Others she used for storing corn, and others, again, for drinking vessels

Miming and Handwork

Let the children act the way in which Yama ground flour.

Let the children make pots.

The first method of making a bowl is by fashioning a lump of clay into a ball and then hollowing it out and pressing the sides to make the shape.

A second method is to let the children make a round base and form the sides by adding piece to piece.

A third method is the coil method. Before each layer is added moisten the top one with water to make it sticky. As the vessel is built up the coils must be pressed together so that no holes are left.

Lighting the Fire

One of Yama's tasks was to see that the fire was kept alight She was very careful not to let it out, because she did not like having to bother to light another.

Long ago man had learnt to make fire. We can imagine an early man who picked up a stone to use as a hammer He struck hard on a piece of flint to shape a new tool for himself Great was his surprise to see a spark fly. He struck

again and again, delighted and astonished at the shower of sparks.

As it happened he was sitting on some very dry moss. The sparks fell on the moss and it see a fire in a strange place. He was eager to show her what had happened. He made another shower of sparks a little way from the fire he had just made, and lighted another little fire.

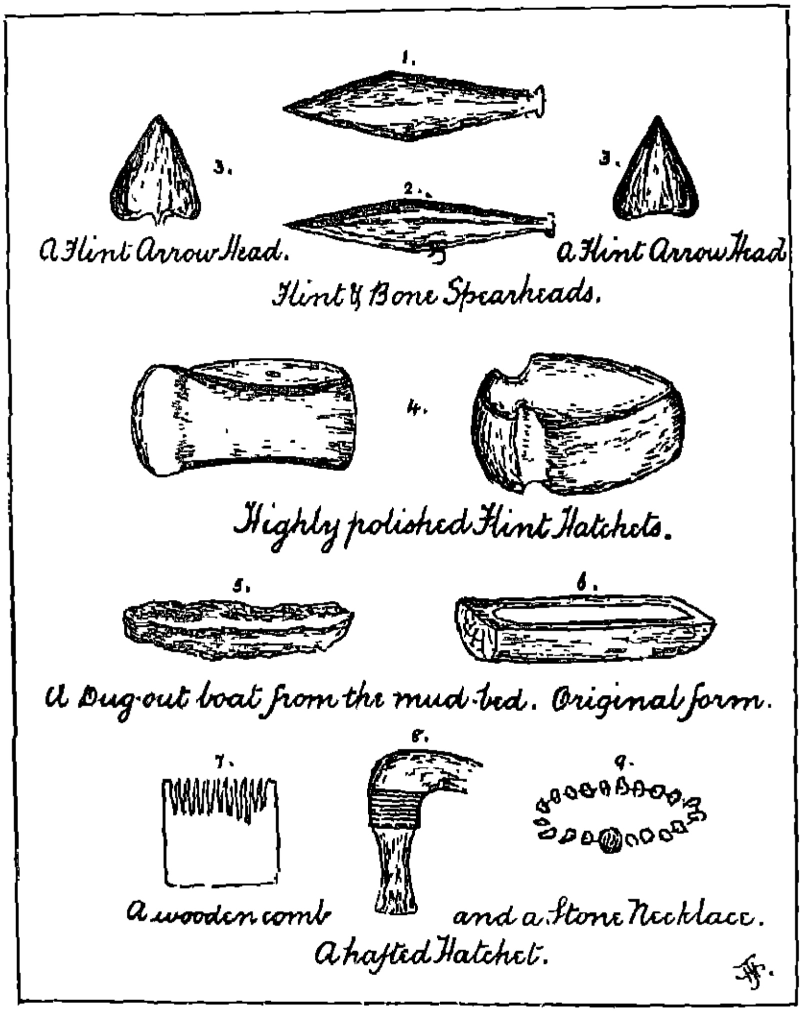


FIG. 31

Achievements of the New Stone Age

began to smoulder. He kept up the supply of sparks, and there was a fair breeze. Soon a little blaze appeared. He found a few very dry twigs and set them on the smouldering moss. They burnt, and soon there was a little fire blazing.

His wife came out and was much surprised to

Then they both though over what had happened, and it occurred to them that they had never seen sparks fly from stone before. They reasoned that there must be something peculiar about the hammer stone that he had used on that day. He had picked up, though he did not know its name, a lump of iron

pyrites which is commonly found in many parts of the world.

The other people who lived near these two fire-makers listened to the tale, and came to see the fires that had been lighted. All the women agreed that it would be a great convenience to them if they could light a fire at will. So they and their husbands set to work to find other stones like the one the first man had used. After long searching and many disappointments they all provided themselves with lumps of iron pyrites, and could light a fire whenever they wanted. Bara and Yama still used this way of making fire.

The teacher can illustrate the lesson by making sparks by striking steel on a piece of flint-stone.

Tell the children to look out for the sparks which sometimes fly from the contact of a horseshoe with the stones of the road.

A Visit to a New Stone Age Flint Mine and Factory

New Stone Age men had discovered that flints from the depths of the earth could be more satisfactorily worked than those picked up on the surface. The three most famous mines worked by the New Stone Age men in Britain are at Cissbury in Sussex, at Grime's Graves in Norfolk, and at Brandon Heath in Suffolk.

Imagine we have visited one of these mines and factories. We were taken down the shaft which was about 40 ft. deep, and then along the lowest gallery, which ran horizontal to the shaft. As we passed along we noticed that the miners had left at intervals blocks of chalk to hold up the gallery.

Some of the miners were using picks of deer horn to dislodge the flints from the chalk in which they were embedded. Others were shovelling with the broad shoulder blades of oxen. Some were using chipping tools made of flint, wedges made of deer horn, and punches for getting out the chalk. Others brought to the surface the flint in the form of nodules. As it was dark underground the miners used little lamps. Into small hollowed-out lumps of chalk they placed tallow, and dried moss for a wick.

When we had made our tour underground we returned to the surface and noticed various shallow holes fairly near to the head of the shaft we had visited. We were told that when the miners had exhausted one mine they opened another, and then threw into the disused mine the rubbish got out from the new shaft.

On the surface between the pits were the workshops which we visited next. We saw the flint workers take the nodules, which had just

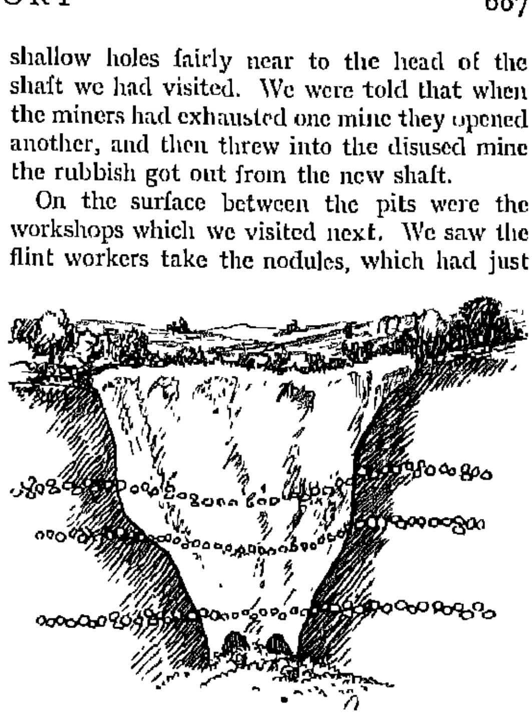


FIG. 32

Flint Mine of the New Stone Age

(Section shows the layers of flint and the tunnels or mine galleries at the bottom.)

been brought up from the mine, and roughly shape them by flaking. Old Stone Age flint workers continued to flake until the flint was finished, but these New Stone Age workers made tools and weapons with a much better edge by grinding and polishing them. For this they used, not a rotating grindstone, but a slab of sandstone against which they rubbed the tool they were grinding.

One of the workers was making an axe. We went close to him to watch how he was making it, since he could make far better axes than the men of the Old Stone Age. Unlike them, he knew how to make an axe with a handle. First he found a stout stick and then he made a slot in it near to one end. Next he took the axe head, which was already polished, and inserted the smaller end into the slot and pushed it through the slot as far as it would go. When it was used each blow wedged the head still more closely into the handle.

Near him was another worker who was making an axe in another way. Sometimes he was lucky enough to find a stone with a hole in the middle. If so he gave it to someone to grind and polish. Then he slipped a stick through the hole and had a splendid hammer. Usually, however, he had to make a hole in the stone. He put some gritty sand on top of the stone and then bored a hole with a stick or a hollow bone.

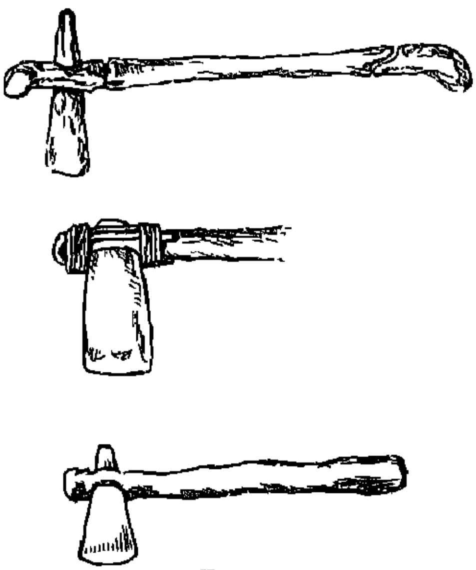


FIG. 33

How New Stone Age Axes were Made

When he had bored about half way through he turned the stone over and began boring from the other side. This way of making axes took a long time, but workers in those days did not mind spending time.

These axes were used to cut down trees and do all the rough carpentry. We were told that before the time when this kind of axe had been made carpentry had scarcely been possible, for the roughly chipped flints were not very useful for cutting wood, but these new axes would cut the softer woods such as spruce and fir.

Another worker was engaged in making adzes He took the properly polished flint and fitted it at right angles to the handle. Any branched stick could be used, and the flint was bound to it by hide thongs. These adzes were used like a hoe, and were useful for tilling the soil and for the making of dug-out canoes.

Some of the workers made weapons. Battle axes were made in the same way as hammers, but they were made with larger flints and with bigger handles. Others were binding long flakes to the end of long shafts to make spears and javelins, while others were working little arrow heads

Practical Work

With twigs, stones, and string let the children make the weapons and tools described, and with clay model the tools and weapons. Encourage them to use these lessons as material for their make-believe in playtime

Lake Dwellers of the New Stone Age

Some of the people of the New Stone Age lived, not on the heights, but in the midst of lakes. They chose this position, which seems strange to modern people, so that the surrounding water should protect them from their enemies.

In the middle of the lake was some marshy ground which was not suitable to live on until the men had strengthened it. They gathered brushwood from the neighbouring forests, and when they had large quantities they covered the marsh with it. Then, with their stone axes they sharpened pointed piles out of straight branches, and drove them firmly into the marsh to hold the brushwood in place. Then they spread smaller branches and brushwood on top of the platform they had made, and upon this they put earth. Thus they made a floor raised well above the level of the lake.

On this floor the lake dwellers built their huts. First they set up upright poles. Then they wove withies in and out of these uprights. To keep out the draught they covered them with mud from the lake.

For thatch they used rushes which they had earlier gathered from the lake side and dried in the sun, or else they cut turves from the neighbouring fields.

When all the huts had been built the men of the little community made a palisade all round the little settlement, and thus they felt safe from their enemies.

These men often used a boat. They had rafts

made of two or more logs tied together, as the later Cave Men had.

It chanced that one day one of the lake dwellers could not find any of the rough boats usually in use. He saw near the river the trunk of an old tree lying on the ground. When he reached it he was disappointed to find that it was a willow tree hollowed by decay. He decided, however, to risk crossing on it, since nothing else was at hand.

One, more thoughtful than the rest, suggested that they must hollow out the tree trunks for themselves. When the others asked how this was to be done he replied, "Burn out the centre till it is roughly the shape you need, and then smooth out the inside with an adze."

All praised him for this idea. They set to work in this way and made dug-out canoes. After many trials they all decided that the boat was less likely to capsize if its base were flat-

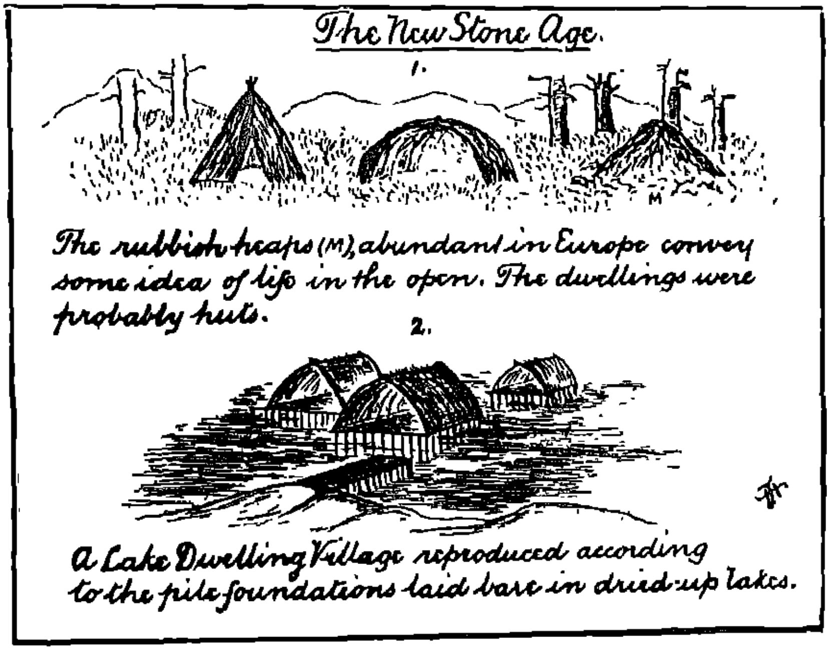


FIG. 34

He sat down in the hollow of the trunk and made a very good passage to the lake dwellings without capsizing. Afterwards it occurred to him that this was perhaps due to the fact that he had used a hollow tree trunk. He spoke of the matter to the others in the little settlement, and they each tried it and came to the conclusion that a hollow tree made a better boat than two logs tied together.

The men of the settlement then searched for all the hollow tree trunks in the neighbourhood. When they had used up the supply they discussed what they could do to provide themselves with more.

tened. These dug-out, flat-bottomed boats were used in Britain until the coming of the Romans.

Handwork

Set up a model of the lake dwelling in the sand tray. Blue paper will represent the lake.

The children can model in clay dug-out canoes.

The teacher can make a few models of dug-out canoes from halves of corks. (Figs. 31 and 76.)

Barter—the First Traders

It was in the New Stone Age that trade began. In the Old Stone Age every family took it for

granted that it must supply all its needs. The New Stone Age people had more needs and they had begun to specialize in their work.

For example, some men, the most adventurous

FIG. 35
Pile Dwellings used to-day in the South Pacific Islands

ones, spent almost all their time in hunting, and thus they got more meat than they required, and more deer horns than they could make use of. The wives of the hunters cured the skins, and they found that they had skins to spare.

However, a family of hunters needed the corn and the cattle which the men who were farmers produced. The hunters, therefore, took with them the horns and skins which they did not need and offered them in exchange for wheat which they wanted for bread. The farmers were very glad to buy the skins and horns and everything else that the hunters had to sell because they were far too busy tilling the soil and tending the animals to have time to go often on hunting expeditions.

The hunters had need of weapons, spears, and swords, and they knew that they could get better ones from the flint workers than they could make themselves. Taking with them, therefore, some skins that were already cured and some horns that the flint workers could use for picks in the flint mines, they journeyed to the flint factory and there gave the skins and horns in exchange for the weapons that they needed.

In the same way the farmers needed tools which were better than they could make, and they took with them corn and offered it to the flint workers in exchange for axes and adzes. No doubt it was sometimes difficult to work out an exactly fair exchange.

Note. The children will easily understand the principle involved in barter, since they barter one cigarette card for another.

The Burial of a Chief

The Chief of one of the hill forts had just died, and since the New Stone Age men believed that there was another life after death, the men of the tribe dwelling in the hill fort were determined that he should be buried as was right and proper.

After long discussion the men of the hill fort

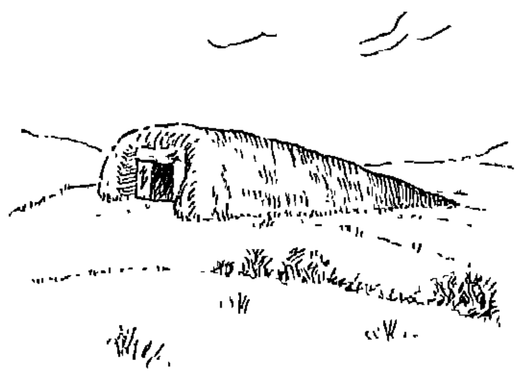


FIG. 36
A Barrow

decided that nothing less than a chambered barrow would be suitable.

The making of this barrow took the men a

very long time. First they set to work to erect a pile of stones something like a dolmen (Fig. 37). Then they made a passage 10 or 15 ft. long and about 4 ft. wide made of large upright stones set beside each other and roofed with great stone

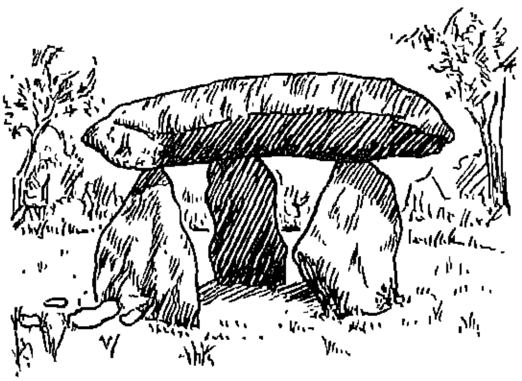


FIG. 37
A Dolmen

slabs. This was a very difficult and lengthy task, but they spared no pains to do honour to the chief.

When the passage was finished they heaped earth over the whole.

The grave was then ready for the chief. His body was reverently carried in procession to its resting place at the end of the gallery, and beside it they placed food and weapons so that the chief might have all that he needed most in the new life. Then they closed the door with a block of stone.

Finally, all round the edge of the barrow they set up a line of upright stones. The entrance to the tomb was marked by two huge stones as door-posts with sometimes a third as lintel

In later times people forgot how to build the long barrows, and made only a small chamber, a dolmen, or cromlech, covered with earth. A dolmen was made with three or four large upright stones with a cap stone as roof Then the body of the chief was placed in the dolmen and the whole covered with a mound of earth

These burial places, dolmens and long barrows, are to be found on the hill sides not far from the hill forts. The dolmens in the course of ages have often lost all their covering of earth, and the stones stand in a lonely field looking like a great stone table. Sometimes a single standing stone is to be seen. This is called a menhir It may mark a burial place, or it may have some religious meaning.

Handwork

Let the children model in clay a dolmen, the exterior of a long barrow, and a menhir. In the sand tray let the class set up a scene to represent the burial customs of the men of the New Stone Age.

Stonehenge

The most famous of all the religious monuments which men made first at the end of the New Stone Age and rebuilt at the beginning of the Bronze Age, was Stonehenge on Salisbury Plain. Let us pay a visit to it to-day.

We cross Salisbury Plain and strike first an avenue on each side of which is a ditch and a bank. We pass along this avenue, notice a large solitary pillar, called the Friar's Heel, and come to a shallow circular ditch and bank about 300 ft. in diameter. We cross this and come to the first circle of stones.

The outer circle of stones originally consisted of thirty huge stones standing over 14 ft. high

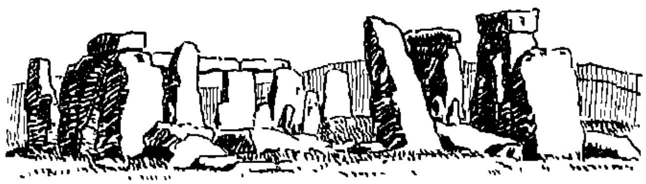


FIG. 38
Stonehenge as it is To-day

by 7 ft. wide, and $3\frac{1}{2}$ ft. thick. On top of these were placed stones which we call lintels. Each one of these was hollowed out on its inner side to fit into tenons which jutted out of the top of the upright stones.

Within this circle was another of smaller stones, blue in colour, without lintels on the top These stones were brought from South Wales.

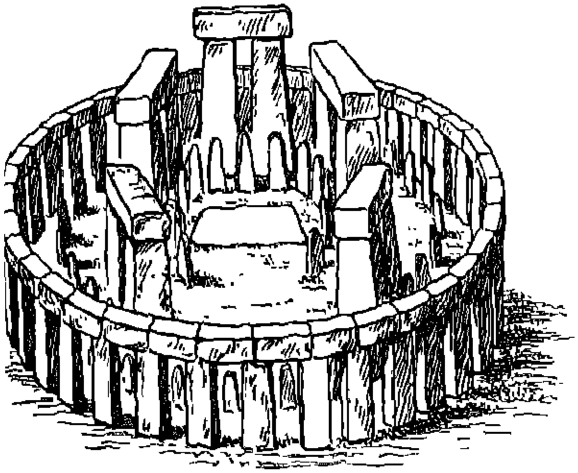
Within this were five magnificent trilithons arranged in a horseshoe plan. Each trilithon

consisted of two upright stones and one lintel. The mightiest of the trilithons, the one that faces us as we enter the circle from the avenue, is 21 ft. from the ground to the underside of the stone on top

Within this stands a row of smaller single stones also in the shape of a horseshoe.

In front of the middle of the mightiest trilithon is a flat altar stone.

We do not know with certainty how men used the temple they had built, but we can be sure that it meant something of very great importance to them or they would not have taken the enormous amount of trouble necessary to find



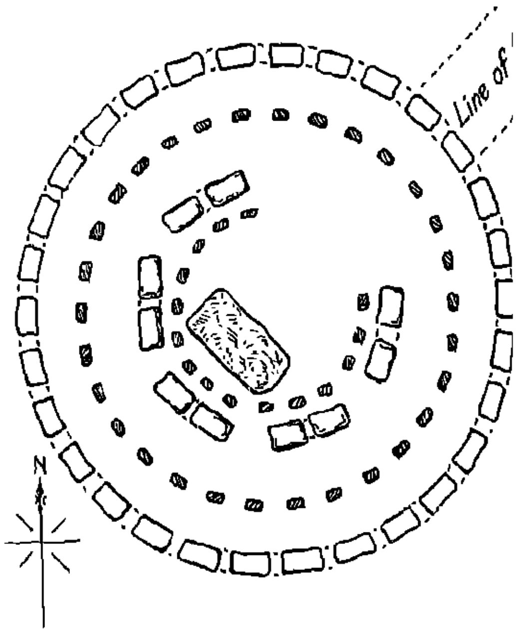


FIG. 39
Imaginary Reconstructions of Stonehenge

the big stones and to work them into shape with the stone tools that were all that they had. Next they had the difficulty of bringing the stones to Stonehenge, and that probably without the help of wheels. Finally, they had the task of setting up the huge stones in position, which proves that they had an elementary knowledge of the laws of leverage. (See SCIENCE OF EVERYDAY LIFE, page 863.)

It is an interesting fact that if anyone were to stand on the altar stone at dawn on Midsummer Day, look towards the Friar's Heel and then gaze beyond, he would find himself gazing at the rising sun as it came above the horizon. From this fact people have supposed that this was a temple for the worship of the sun, with whose movements the men of the New Stone Age were well acquainted.

Another interesting point is that near to the various stone circles which are to be found in many parts of Britain and Western Europe are long barrows. It has, therefore, been suggested that the stone circles have some connection with the worship of the dead.

Others, again, think that the stone circle represents a place of meeting for the folk of the neighbouring camps. It is a striking fact that these stone circles are to be found at the meeting places of the upland trackways.

In the New Stone Age there are no wonderful drawings such as the Cave Men made, but instead there are these impressive temples.

Handwork Exercise

With bricks the children can set up a model of Stonehenge, and they may be encouraged to make, at school and at home, clay models of The New Stone Age worshippers.

THE BRONZE AGE IN BRITAIN

Even before men in Britain were using bronze, Great Britain was separated from the Continent, and Ireland was separated from Great Britain. The climate was practically the same as it is to-day. The animals and the trees were the same as they had been in the New Stone Age.

No one knows for certain where the Bronze Age men who settled in Britain came from, but it is likely that they came here from Brittany and other parts of France.

Again, we do not know how or when they first came, but probably they arrived in small groups at different times, and settled down without much fighting alongside the New Stone Age men

There was a difference in appearance between the New Stone Age men and the Bronze Age men. The former were wiry, dark, long headed men, while the latter were stalwart, dark, broad headed men.

In many ways they lived like the New Stone Age men. They dwelt on the heights and used the same forts or made others like them. They travelled along the same trackways from fort to fort. They had the same kind of religion for they, too, used Stonehenge and the other stone circles that dotted the high ground. They buried their dead with great care, but instead of raising over them long barrows, shaped like half a pear, they made round barrows, on which, on the whole, they spent less time and care. What chiefly distinguished them from the men of the New Stone Age was their knowledge of the use of bronze.

The Finding of Copper

Once a man named Gard was travelling far from home. At night he gathered together some large stones, and on them built his fire and cooked his evening meal. Then he went to sleep waking at intervals during the night to keep his fire alight.

In the morning, when he was just about to cook his breakfast, he noticed that something was gleaming ruddy yellow in colour among the embers. He let the fire out, hacked the yellow stuff away from the stones with his stone axe, and carried it away, wondering what it was.

Next time he had occasion to travel that way exactly the same occurred. This time he noticed that the ruddy yellow stuff, before it got cold, was liquid like thick water He built another fire and put a bowl underneath to catch the liquid. Great was his surprise when he found that the ruddy yellow liquid, when cold, took the shape of the bowl. He had accidentally found out how to make and shape copper.

He returned to his family, and brought them to settle in the spot, so that he could make further experiments, for it occurred to him that he could make tools and weapons in the new substance more easily than the flint worker could make stone weapons He made a number of moulds of stone in the shape of an axe head. He then melted the ore and poured it, in its molten state, into the moulds. When the metal was cool he took out of the moulds a number of axe heads with far better edges than any axe of stone had ever had

After this Gard was always busy He could never make as many weapons and tools as he and his neighbours needed. He made axe heads, spears, swords, chisels, and awls.

Gard's neighbours had no money with which to buy his weapons and tools, but they gave in exchange corn and other things which he needed and they had to spare. Gradually the news spread that Gard was making tools and weapons that were far more useful for cutting down trees, making huts, and doing all other things than the stone weapons had been Traders, therefore, came from afar to buy them in large quantities to sell again in the districts where people did not yet know how to work copper

More and more people learnt how to make copper goods, and gradually men gave up using their stone weapons and tools, and used copper ones instead.

A Visit to a Copper Mine

After the discovery that copper was useful for the making of weapons and tools, men searched Britain to discover where copper was

to be found. They discovered it in Cornwall, Cardiganshire, Anglesey, and Derbyshire, but the best district for their purpose was Cornwall,

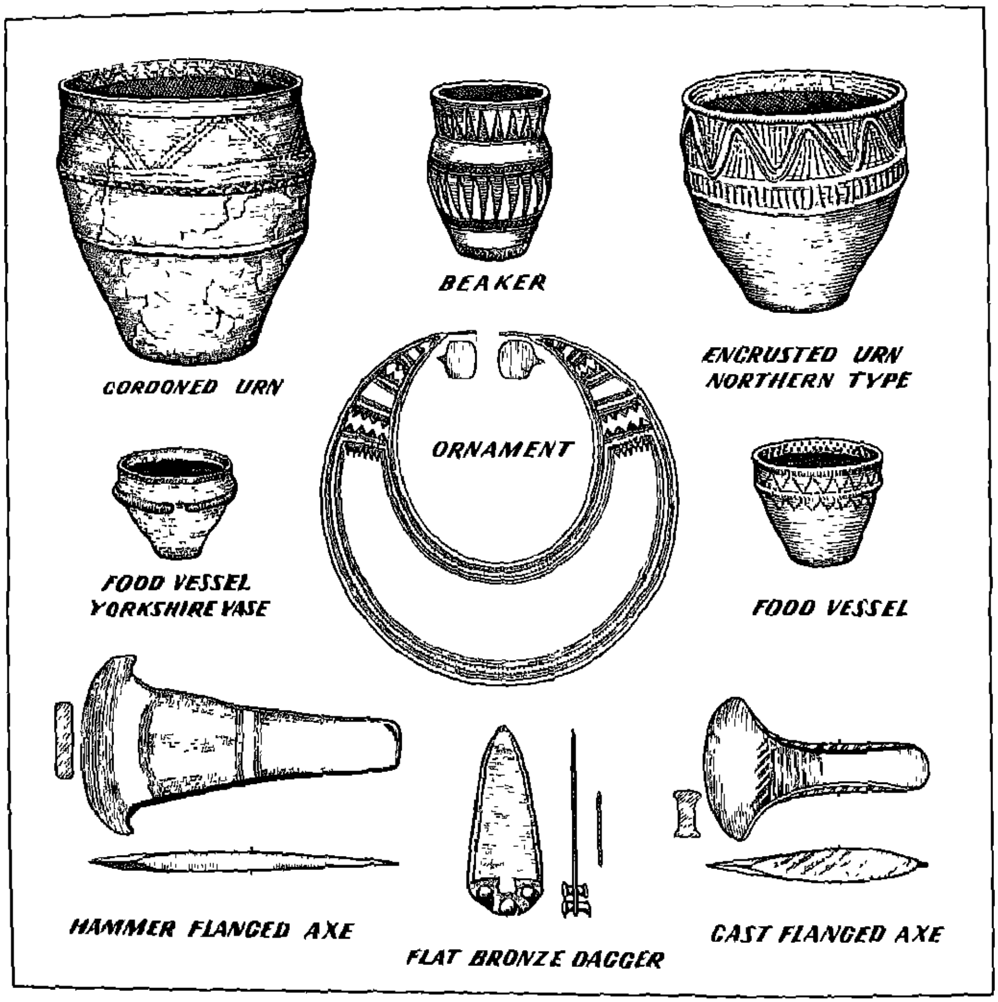


FIG. 40

The Bronze Age

because tin also was found there, and Bronze Age men early discovered that nine parts of copper mixed with one of tin made a metal, bronze, that was better adapted to their purposes than pure copper.

To-day we will visit a copper foundry. Some of the men are busy mining for the copper. Others are employed in crushing up the rock into small fragments with mullers in mortars.

Others are grouped round the smelting furnace. This is a shallow pit about 1 ft. in diameter. First the men fill it with charcoal, that is, with wood partially burnt. This they set on fire. Then they fling a fresh layer of charcoal on top, and on this throw some pieces of copper and tin ore which has already been pounded small in the mortars. On this they put more

charcoal, and then on that more copper and tin ore until a heap of ore and fuel rose above the hole. As the wind blew the fire burnt more brightly, and the metal in the ore melted and ran into the pit below. When all the ore was smelted the fire was raked away and the hot bronze was disclosed.

Then the men got this out of the pit before it went hard and cold, and broke it into lumps called ingots. The refuse after the copper and tin had been extracted, the slag, was thrown aside.

One of these foundries has been found in Anglesey. The floor is still strewn with slag, the mullers and mortars for crushing the ore, and the other remains of the smelting furnace.

To these foundries came the traders who bought the bronze ingots by barter, giving something in exchange for them. The traders sold them again to the bronze smiths, who, in return, gave them some article that they wanted. We know this because these ingots, the bronze smith's tools, and unfinished implements have been found far away from the mining districts.

The Bronze Smith

When the bronze smith wanted to melt the ingots of bronze he had bought from the trader he built a charcoal fire above a clay crucible, and flung pieces of metal upon it. As the metal melted it trickled down into the crucible. He poured the molten metal into clay moulds already prepared, and shaped to form axes and spear heads. This method of casting it in open moulds could only be used for flat implements such as knives.

One day it occurred to the bronze smith that two open moulds held face to face would make a closed mould with which he would be able to cast in the round.

Then a particularly clever bronze smith thought of a way of casting so that the shaft of the spear would fit right into the bronze. He did this by making the mouth of the mould larger and circular. As he poured the molten metal into the mould he held a small clay core within the mould by means of a bit of wire. This clay core was the same shape and size as the shaft. When the spear head was cast the clay core was scooped out of it, leaving a socket in which the shaft could be inserted.

As spear heads increased in size they became too heavy. Then an ingenious bronze smith thought out a way to make the whole of the bronze work hollow.

Toward the end of the Bronze Age certain articles began to be made by another method. The smith beat thin plates of metal out until they were thin enough to serve his purpose. Then he cut the bronze into shape and bent and riveted it together. In this way hollow vessels, such as cauldrons, were made. In this way, too, the circular shields, called bucklers, were made. They have a large central boss surrounded by raised concentric rings and lesser knobs or studs. This decoration is done by hammering (See Fig. 76 (*b*).)

Handwork Exercise

Modelling in clay the various weapons and tools that the bronze smith made will provide scope for both clumsy and dexterous fingers. This may lead up to a discussion of the obvious differences of method imposed by various media.

The First Spinners and Weavers

In Britain it is likely that before the Bronze Age people did not know how to spin and weave, though in some parts of Europe this craft was known in the New Stone Age.

When the farmer cut the wool off the lambs' backs in spring, and when he killed a sheep, he brought the wool to his wife. Her first task was to wash the wool, and her next to dye it. To dye the wool she boiled some vegetable substance with the wool in her bronze cauldron.

Next she teases the wool, using teasels to make the wool fluffy (Cf. Fig. 8) Then she oils it and cards it For carding she has special implements rather like two butter pats with nails stuck through them. She puts the wool on one of the cards and then pulls the other card across it. After carding the wool is ready for spinning.

To spin, she first bunches the carded wool on to the top of a distaff, which is a piece of stick. She sticks the lower end of the distaff into a band that she wears round her waist.

Then she takes a spindle into her left hand. A spindle was a piece of wood about 1 ft. long and ½ in. thick. At one end was a notch which

WARP WEIGHTED LOOM

FIG. 41

made the spindle look something like a crochet hook. Toward the bottom of it was a rounded clay weight, called a whorl.

The spinner draws a little thread from the distaff and fixes it on to the spindle. Then she gives the whorl a little flick with her fingers which sets it rotating. As it rotates the weight of the whorl carries it to the ground, and the twisting motion makes the wool into yarn. When it reaches the ground she picks up the spindle and winds on to it the thread that has been made. Then she repeats the operation time and time again till the spindle is full.

When she has made all the wool into spun yarn in this way her next task is to weave it into cloth.

First she makes her loom out of two straight branches of trees which have a convenient forking at the top. These she sets up with another branch resting on top of them. She then takes long threads of yarn and passes them over the top of the frame, and at the bottom she attaches to the threads weights which serve to keep these warp threads properly stretched. She takes as many of these warp threads as will make the cloth the width she requires.

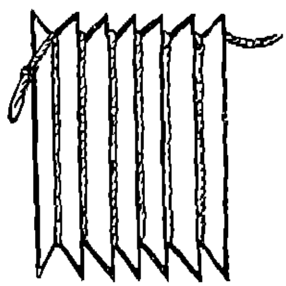
Then, taking a skein of yarn in her right hand and picking up the warp threads one or two at a time with her left hand, she passes the weft threads through from side to side over and under the warp. After every two or three rows she takes a wooden lath and beats the weft threads up so as to make the cloth compact.

When the piece of cloth is woven her next business is to make the clothes for herself, her husband, and her children. Probably she does not shape the garment much, but she has bronze needles with which to sew, bronze buttons with which to fasten garments together, as well as bronze pins and brooches for fastenings.

Men and women of the Bronze Age gave much thought to their personal appearance. Men shaved with bronze razors, and both men and women wore necklaces, ear-rings, finger rings, bracelets, armlets and pendants, twisted metal collars called torques, and crescent shaped collars. These articles of jewellery were made of gold, copper, bronze, ivory, jet, amber, glass, and bone. Women dressed their hair with bronze pins and slides.

Activities

Weaving may well be introduced to the children by the teacher bringing small pieces of coarse canvas, sacking, or hessian so that the



CARDBOARD LOOM.

FIG. 42

children, by unravelling it, may discover how it is made.

If they are then given a few strands of wool or raffia they can try to make a mat. They will quickly lay out the warp threads, but when they attempt to thread the weft in and out they will find that the warp threads slip about, and that they cannot bring the weft threads closely together without displacing what has been already done.

One of the children may then think of tying the warp threads round something such as rulers or sticks The loom is still not rigid, and the next advance may be to add two sticks at the side so that a parallelogram is formed. The children next find that they cannot remove the work from their frame without injuring it.

Finally, the idea may be evolved that cardboard looms with notches cut at regular distances to receive the warp threads satisfy their requirements. In course of time the class will reach the conclusion that putting the weft in with the fingers alone takes a long time. One of the children will doubtless remember that her mother uses a darning needle This will lead on to the idea of a shuttle, which can then be made.

THE IRON AGE IN BRITAIN

About 800 to 700 B.C. the first of the Celts came to Britain from Gaul, as France was then called. We call them the Goidels, and we believe that they came a few at a time and settled down fairly peaceably with the earlier inhabitants. They came toward the close of the Bronze Age.

About 400 B.C. another invasion of the Celts began. These were the Brythons, who came from Gaul, and who gave their name to Britain. They appear to have been very warlike, and to have conquered the country district by district. It was they who brought the use of iron into Britain.

Then, about 200 B C. there came to Britain tribes of the Belgae, the most warlike people of Gaul. They conquered the south and south-east of Britain, and then settled down to cultivate it. They were not purely Celts, for while they used the same language as the Brythons they had more northern blood in them.

The coming of these peoples to Britain is of great interest because their speech is akin to our own, whereas we have no record of the speech of the previous inhabitants of Britain. The Goidels spoke a language which is the origin of Gaelic, Manx, and Irish. The Brythonic language is the origin of Welsh, Breton, and of the Cornish language which has now died out.

In appearance these Celts were tall and muscular, but rather loosely built. Their eyes were blue, their skin fair, the head long and covered with untidy yellow or reddish hair. They shaved their beards, but grew long moustaches.

The Discovery of the Use of Iron

During the Bronze Age men probably discovered that iron was a metal somewhat like bronze and that, when it was heated, it could be shaped just as bronze was shaped. They did not, however, value iron much because it was softer than bronze, and not so useful for the making of cutting and piercing implements.

Then perhaps by chance it happened that a man who had been hammering a piece of red hot iron let it fall into a vessel full of cold water.

He was angry with himself for his clumsiness, because he thought that he would have to heat up the iron again and hammer it into shape once more. He put his hand into the water, brought out the piece of iron, and found that it had suddenly become extremely hard.

First of all he was pleased because the dip into cold water had not spoilt his implement. Then he was still more excited because by chance he had found out a way to treat iron that would make it more suitable than bronze for all tools and weapons that needed a good edge or point.

From this time forward iron was mined in Sussex, in the Forest of Dean in Gloucestershire, and at Hunsbury near Northampton. It was smelted in much the same way as copper. The furnace was a shallow conical hole in the ground, in which a fire was lighted, and on it were placed alternate layers of charcoal and crushed ore. The whole was kept at a high temperature for some six hours by the blast of some rude

form of bellows. Then the pasty soft lump of metal at the bottom of the furnace was taken out while it was still hot and hammered into a rough block.

Traders bought the iron in this rough state and sold it to the smiths for them to shape into implements and weapons of all kinds.

Glastonbury Lake Village

Glastonbury in Somerset is the most famous example in England of an early Iron Age village. It is believed that it was first made about 100 B.C., and that it was attacked and destroyed about A.D. 50.

Let us imagine we have visited ancient Glastonbury. As we approached we saw a man near the edge of the lake on the mainland. He was the man who would act as our guide on this occasion. Beside him was a canoe which would take us over to the island. It was about 18 ft. long and was about 1 ft. deep, with a shaped prow and a graceful rise both at prow and stern. The guide told us that the islanders used the canoe for crossing to and from the mainland and for fishing. In fact, we could see at the bottom of the boat one of the fisherman's nets, which was fitted with lead sinkers.

Meanwhile, we had crossed the water and reached the landing stage which was at the end of the causeway that the islanders had made from their village to the edge of the lake. We got out of the canoe and noticed the strong encircling palisade the villagers had made. Looking closely we saw that they had driven stout oak planks into the peat, and then fixed to them horizontal boards.

As we walked our guide told us how the village had been made He said that originally Glastonbury was an island of soft peaty ground surrounded by the waters of a shallow lake. To make the island fit for dwellings the settlers had first laid down a layer of logs, brushwood,

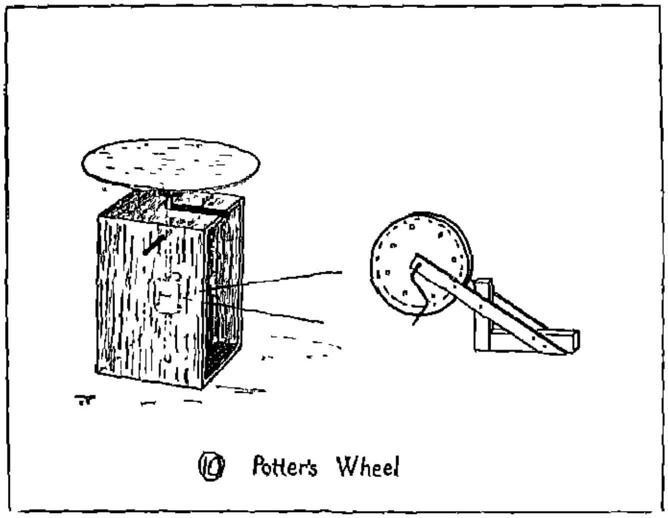


FIG. 43

A Potter's Wheel

This little model can be made in school. The axle is a penholder, to which two reels are firmly fixed. A wooden or card disc is fitted to the top reel by nails or screws. The chalk-box base has a slit wide enough for the axle and a hole on the bottom arranged for the axle, to keep it upright. A knitting needle keeps axle in place Multiplying wheels (a) cotton reel on axle; (b) three discs of card fixed with paper fasteners, a square hole at centre, and a square axle tapered round to pass out of supports Supports for driving wheel as shown.

and stones. Then to make their huts they first laid the floor, which they made of circular beds of clay varying in diameter from 14 to 40 ft., and in thickness from 3 in. to 2 ft. Round the edges of the clay beds they had driven posts into the layer of bog and brushwood. These posts formed the uprights of the hut walls. Then the men had filled the spaces between the uprights with wattles, and then plastered these smoothly inside and out with clay. In the centre of the hut they had planted another post. The men had next thatched the roof with reeds or straw, supporting it on the wall posts and the centre post. In the roof they left a smoke vent.

This peat island of Glastonbury seemed to us a strange place to choose for a village, since the building of the huts had been made more difficult in the soft peat. Our guide explained,

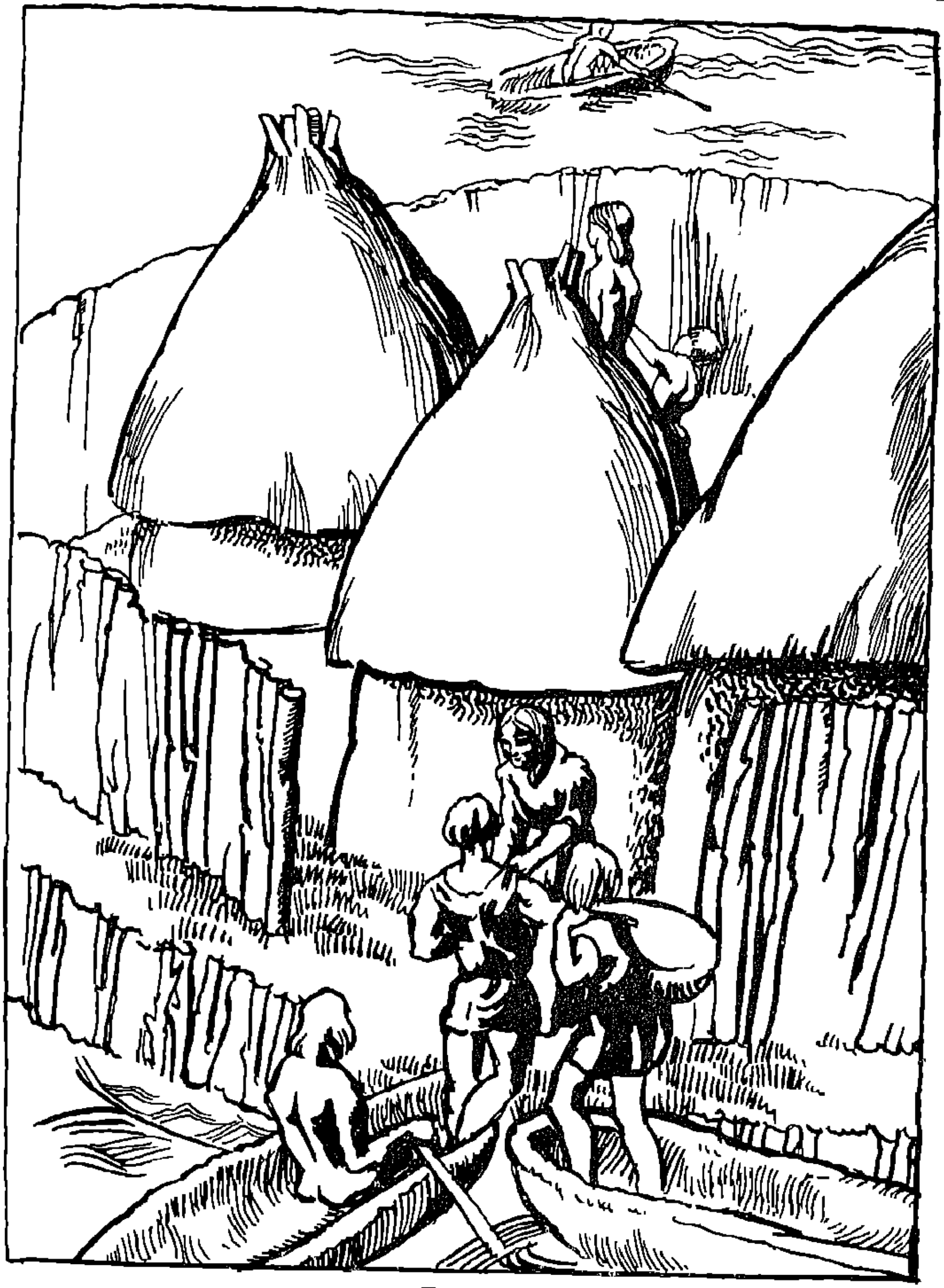


FIG. 44
The Lake Village

too, that the floors of the huts were always sinking, so there was constant need to bring more clay from the mainland. He added, however, that it was a good place to live because the surrounding water made the islanders feel less exposed to the attacks of foes.

We went to examine one of the huts more closely. Its door posts were made of squared timber and the door was made of wood with a lock and key. The circular hut was floored with split wood boards. In the centre stood the hearth, as usual made of baked clay, on which a bright fire was burning, the smoke from which slowly escaped at the vent hole in the thatched roof. Round the walls were low couches stuffed with straw, leather or bracken, and covered with rugs and skins. They served as seats by day and beds by night.

Resting on one of these couches was the husband, wearing a brightly coloured woollen tunic with sleeves, which reached to the thigh and was girt in at the waist. Beneath the tunic he wore loose woollen breeches. On his feet he wore shoes of raw cowhide worn with the hair outside and gathered in and bound round the ankles. He had discarded the large dark woollen cloak that he wore out of doors. This he fastened on with a brooch on his right shoulder. His conical hat rested on top of the cloak.

Near the fire sat his wife. She was wearing a dress like her husband's tunic, only very much longer, reaching nearly down to the ankles. She, too, had a big cloak like her husband's for use outside.

She was busy cooking the dinner. Over the fire was an iron tripod with a long pot hook on which hung a bronze cauldron. At hand on the floor were earthenware cooking pots of all shapes and sizes, and a pottery colander for straining. Ready for serving the meal she had plates and dishes of pottery as well as wooden spoons, trenchers, bowls, and cups.

Beside the walls of the room stood her wooden tubs and buckets and large pans for storing grain, jars and bottles with wooden stoppers.

Away from the hearth sat the eldest daughter, busily grinding corn For this she had an up-to-date rotary quern. The lower stone was fixed to the ground. From the centre of it projected a wooden peg which fitted into a socket in a piece of wood fitted across the central hole in the upper stone. The upper and the lower mill stones were in contact and the corn was ground between them, being fed into the mill through the central hole in the upper stone. The girl sat and turned the upper stone by means of a stick fixed in a hole, and the flour came out from the sides of the stones.

The wife and daughter were able to provide the family with a varied diet. They cooked beef, mutton, pork, goat and horseflesh, red deer, roe deer, and wild boar. They enjoyed crane, wild duck, teal, goose, swan, and ate oysters, trout, and roach. From the corn they made baked bread and little cakes sweetened with honey. As vegetables they used broad beans and peas, and they had sloes, blackberries, dew berries, and elderberries. In autumn they gathered hazel nuts.

The guide took us into another hut where a man was busy making pottery. Though women still made pottery by hand as they had done in the New Stone Age, by this time a primitive potter's wheel was in use in Britain. The potter placed the clay in the centre of the wheel, and turning the wheel with the one hand he shaped the soft clay with the other. By this means he was more sure of making the pottery true in shape than if he made the pottery by hand In his hut there were far more pots than he needed, and our guide told us that they were for sale.

In another hut a carpenter was at work surrounded by all his tools. He had an axe and an adze, a chisel for planing, a draw knife, gouges for cutting grooves and holes, punches and awls, and a wooden mallet. Close at hand was a file and rasp for sharpening his tools.

At the moment he was busy using his saw Its teeth were set or bent alternately to either side, as are the teeth of modern saws, so that they could cut a little wider than the thickness of the blade itself. What we noticed was that he pulled the saw toward him, instead of pushing it away from him as modern carpenters do When we inquired the reason he said that he was afraid the thin saw would break if he were to push it through the wood.

A new tool which some carpenters had at this time was a lathe, with which they were able to

make beautifully turned naves and spokes of wheels and bowls.

By this time there were many different workers in wood. There were the carpenters who made the looms, the lathes, the potters' wheel, and the ladders. There were the coopers who made tubs and buckets and barrels. There were the wheelwrights who made wagons and war chariots, and shipwrights who made the canoes and boats. We saw all these different workers in wood in the village of Glastonbury.

In one of the huts lived a man who specialized in making bone needles and pins, in another a bronze smith who worked in much the same way as did the bronze smith of the Bronze Age, and numerous blacksmiths were busy making the iron tools and weapons from the iron ingots that were made at the iron foundries. Other men were leather workers, skilled in the tanning of hides and the dyeing of leather, and the making of beautiful horse trappings.

While we were looking at the bronze smith's work there came up merchants with tin to sell. They said that they had bought the tin in Cornwall, and that they had seen the ore ground down and smelted. After that, the tin was purified and cast into knuckle-bone shapes. From the mines some was carried, they said, in wagons to an island (probably St. Michael's Mount) to which wagons could go at low tide. To the island came merchants who bought the tin and shipped it over to Gaul, from which it was carried overland by pack horses to the mouth of the Rhone on the Mediterranean.

The bronze smith was interested in this account of the tin trade. He then took out some money to pay for the tin, for he needed tin to smelt with the copper to make bronze.

The money he produced took the form of iron bars. In shape they were like sword blades, but they were of even thickness, square edged and unpointed, and had the edges at one end hammered over to form a kind of socket. There were five standard weights The unit weighed about 11 oz. The other weights were half and a quarter of the unit, double and four times the unit. Before the Iron Age in Britain men had not used money, but had bartered their goods. There were also gold coins in circulation brought to the island by Greek traders from Marseilles, and after a time the British in the south of the island minted gold coins (see Tally Sticks p. 356).

This money was necessary because by this time each man did not supply all his needs, but he grew or made more of one article than he required, sold the surplus, and with the money

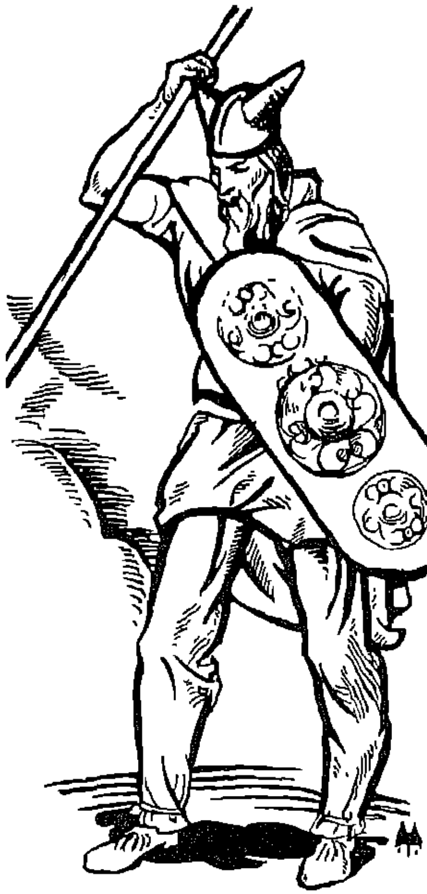


FIG. 45

An Early Iron Age Warrior

bought the goods that he required By this time too, the Britons were trading with the Continent By the first century A.D the Britons exported wheat, cattle, gold, silver, tin, skins, slaves, and hunting dogs, and imported ivory bracelets, necklaces of amber, and glass vessels.

Our guide wished that we should not leave Glastonbury without seeing the farming operations. So we went down the causeway, climbed

officer came and took their names down on a roll of papyrus. Joseph had never been in Egypt before so he looked about him with interest. He saw soldiers in short linen kilts, with bare brown legs and sandals on their feet. Some had padded helmets of bright coloured cloth with a

FIG. 47
Joseph's First Glimpse of Egypt

long fringe hanging down on their shoulders. He stared open-eyed at the heavy bullock wagons and the chariots which were drawn by swift horses, for he had never seen anything like them before The fine ladies he noticed wore long delicate robes reaching to their ankles and beautiful necklaces and bracelets. Their dark hair was plaited into a number of little plaits reaching to their shoulders. Their finger-tips were dyed bright red and they made dark rings round their eyes.

The merchants crossed the flat marshy land till they reached the wide river Nile, and then they followed the road beside the river bank till the Nile became narrower. They came to a city called Memphis built on a long island in the middle of the river.

In the market-place in Memphis Joseph was exposed for sale as a slave. After he had spent some time in the market-place he saw two boys running and carrying white sticks with which they pushed the people out of the way. Following them came a grand chariot with four horses with glittering harness and great feather plumes on their heads. The owner of the chariot got out. People looked at the soldier-like figure, at his heavy gold necklace and the rings on his finger. They recognized Potiphar, the captain of Pharaoh's bodyguard and the keeper of the King's prison. This great man bought Joseph as a slave.

Joseph ran behind his new master's chariot till he reached the courtyard of Potiphar's house. All round the courtyard were low, flat-roofed houses where the servants lived, and stables, store houses, and chariot houses. Beyond the courtyard he came to a garden in the middle of which stood Potiphar's house made of brick and painted with bright colours. Joseph was much awed by it, for he had always dwelt in a tent and was quite unused to such luxury.

Joseph showed himself so useful and so able that after a time Potiphar placed him over all his other servants and slaves. Joseph was very happy until, one day, Potiphar's wife made up an evil story against Joseph and told her husband. Potiphar believed it though it was quite untrue, and threw Joseph into prison.

While he was in prison the chief baker and the chief butler of Pharaoh were also there, and one day he heard of strange dreams they had had. The baker dreamed that birds ate baked meats from a basket he was carrying to Pharaoh. Joseph said this meant he would be executed, and this proved true. The butler dreamed he was standing before a vine squeezing the grape juice into Pharaoh's wine cup Joseph said this foreshadowed his release. Thus Joseph

was able to tell them the meaning of the dreams that they had. The chief butler was released three days afterwards, as Joseph had foretold, but when he was a free man again he forgot to get Joseph out of prison, and Joseph had to stay there two more years.

At the end of this time Pharaoh one night dreamed that he stood beside the Nile, and there came up out of it seven fat cattle and after them seven thin cattle who ate up the first cattle. Another dream he had was that seven good ears of corn grew up on one stalk and seven thin ones on another stalk, and the thin ears swallowed up the good ears Pharaoh was much troubled and sent for his magicians to learn what his dream meant, but they were unable to tell its import.

The chief butler then remembered Joseph and told Pharaoh that he could interpret dreams. Joseph was brought hastily from prison to the palace of Pharaoh. The King was seated on his golden throne with a rich silk canopy over it and round him stood all the nobles, officers, and grand ladies of the palace. Never had the shepherd Joseph seen such magnificence.

Pharaoh described his dream and Joseph thus interpreted it—"The seven good kine are seven years and the seven good ears are seven years. The seven lean and ill-favoured kine that came up after them are seven years, and also the seven empty ears blasted with the east wind: they shall be seven years of famine, and all the plenty shall be forgotten in the land of Egypt and the famine shall consume the land." Joseph suggested that Pharaoh should appoint an overseer to make the most of the seven good years.

The King chose Joseph for this post. He took off his signet ring and put it on Joseph's hand and ordered him to be clothed in fine linen and put a chain of gold about his neck He ordered that Joseph should ride in his second chariot and have runners in front, and that all the people should bow as he passed. Thus Joseph the slave and the prisoner became the ruler under Pharaoh of the land of Egypt.

In the seven years of plenty Joseph made the people sow large crops and use land that had never before been used. In the towns he set hundreds of slaves to work building large granaries in which to store the corn

In the eighth year the river Nile did not rise as usual, and the parched ground could not grow the crops. For seven years in succession this happened. The people crowded to Joseph, who ordered that the granaries should be opened and corn sold to the people.

There was famine in the land of Canaan as well as in the land of Egypt, so Jacob, hearing that there was corn in Egypt, sent his ten sons to buy corn there, keeping his best loved youngest son, Benjamin, at home. They were brought before Joseph, and did obeisance to him as did the Egyptians. Thus were fulfilled the dreams that Joseph had had as a youth. They did not recognize him, though he knew at once that they were his brothers.

He spoke to them roughly and, to prove them, ordered that one should be left behind while the others took back corn to Jacob and brought Benjamin to Egypt. Jacob was at first reluctant to let his youngest son go, but at last consented.

When Joseph had proved that his brothers really loved Benjamin he revealed who he was. Instead of blaming them for their cruelty in selling him as a slave to the merchants, he said that all had happened according to God's will so that he might be able to provide for them in time of need. As there were five more years of famine to come he sent a message inviting his father to come and settle in Egypt.

One morning Jacob, his children, grandchildren, and all his relations, seventy people in all, set out for Egypt. The bullocks that Joseph had sent were harnessed to the wagons, some of which were filled with all the household goods, and in the others were the small children. They crossed the desert and finally reached Egypt

Joseph rode out in his chariot to meet Jacob. After their greetings Jacob and his party were shown the way to the land of Goschen, which was the north-eastern part of the Nile delta There would always be grass close to the mighty river, so that all fear of a famine had passed away.

Jacob lived happily in the land of Egypt for the rest of his life, and Joseph remained the great ruler of Egypt till the day of his death.

PISISTRATUS, TYRANT OF ATHENS

About five hundred and seventy years before the birth of Christ there lived in Athens a youth of good birth called Pisistratus, who was very ambitious.

He first won popularity by leading the Athenians in capturing Salamis from Megara.

FIG. 48
Greeks of the Sixth Century B.C.

Salamis was an island whose nearest point was about four miles from the Piraeus, the harbour of Athens; it was about equally distant from Megara. Great was the rejoicing in Athens over this addition to their territory, for the Athenians knew that they could never become really prosperous until they had gained the island.

Pisistratus, wanting to add to his popularity, successfully championed an unpopular cause. The people of Athens were at this time divided into three parties. The party of the plain was composed of rich men of good birth who owned the fertile lands of the plain around Athens. The party of the coast was composed of rich merchants who lived by the sea Pisistratus organized the hill party, composed of the poor people who were jealous of the other two parties.

One morning the customary crowd assembled in the market-place buying and selling and discussing public affairs was startled by a wild commotion. A mule cart, driven at headlong speed, drew up. In it sat Pisistratus, covered with wounds. He shouted! "A rescue, citizens. Bring rescue to a man hard pressed by assassins, who seek his life."

He then explained that as he was setting out from his farm he had been attacked by his enemies and had with difficulty escaped. An assembly of the citizens was quickly called, and, there being present many of Pisistratus' supporters, the Hill party, he was voted a bodyguard of fifty club bearers.

This was just what Pisistratus wanted. Nobody suspected that he had wounded himself and had made up the whole story. With the help of the bodyguard he seized the Acropolis, a strongly fortified hill overlooking the city, and became a tyrant.

When the Greeks called a man a tyrant they meant that he was able to do as he pleased without consulting anybody. They did not mean that he was necessarily cruel. For five years he ruled well, but at the end of that time the two parties of the plain and the coast combined against him and he was driven out.

One day about five years later a chariot was driven into the city. In it was a woman wonderfully tall and clad in a complete suit of armour with a helmet on her head. Beside her sat Pisistratus and Megacles. Before the chariot ran heralds, who shouted: "Listen, men of Athens, here comes Athene, the patron goddess of your city, bringing Pisistratus, whom she honours before all men, to her temple in the city."

The Athenians worshipped the goddess and made Pisistratus tyrant a second time.

Now the supposed goddess was merely a woman they had found and taught to act the part of Athene. Megacles was the leader of the party of the coast who had fallen out with the party of the plain, and who was won over to Pisistratus' side because his daughter was to marry the tyrant.

After marrying Megacles' daughter, however, Pisistratus did not treat her well, so Megacles combined against him with the party of the coast, and Pisistratus was driven out again.

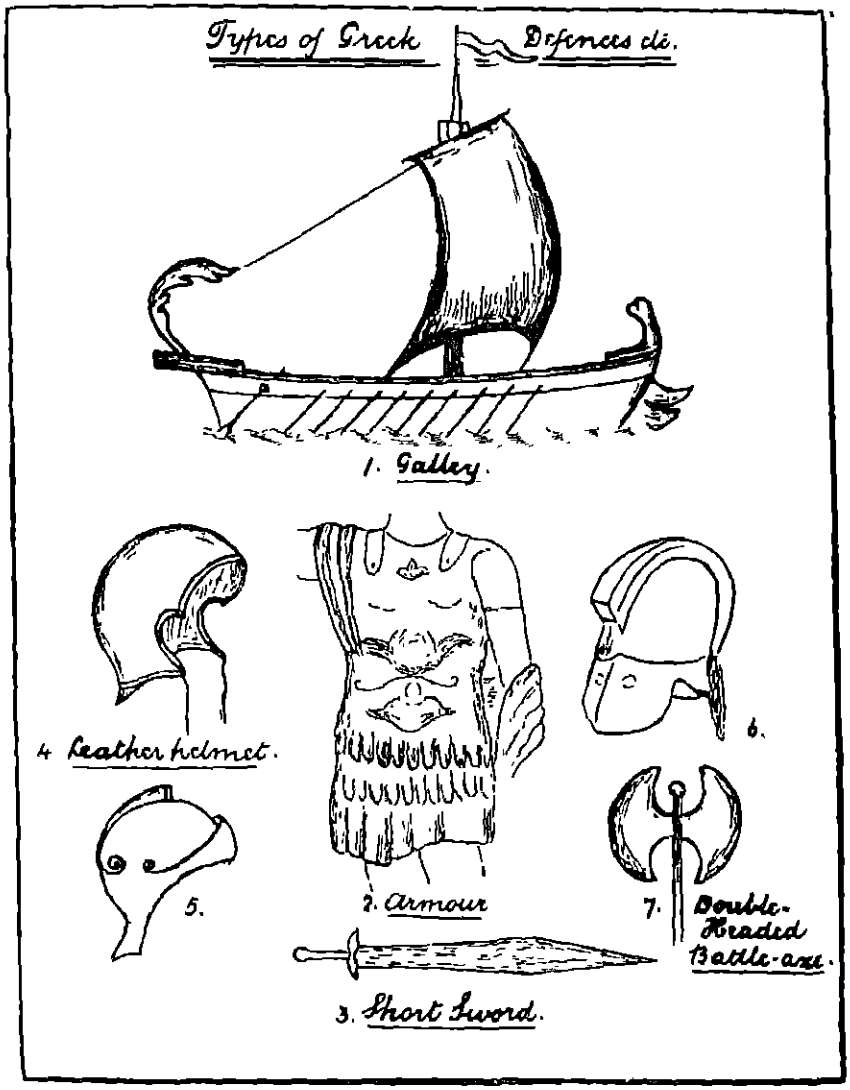


FIG 49

For ten years Pisistratus lived in exile, spending his time collecting money and friends, Then, when all was prepared, he and his two sons, Hippias and Hipparchus, crossed to Marathon and there found many adherents.

Megacles and his men marched out of Athens, but they despised their enemy and Pisistratus was easily able to defeat them and make himself tyrant of Athens for the third time.

One day Miltiades, one of the leaders of the party of the plain, was sitting in the porch of his country house when he saw a company of men in Thracian dress carrying spears passing

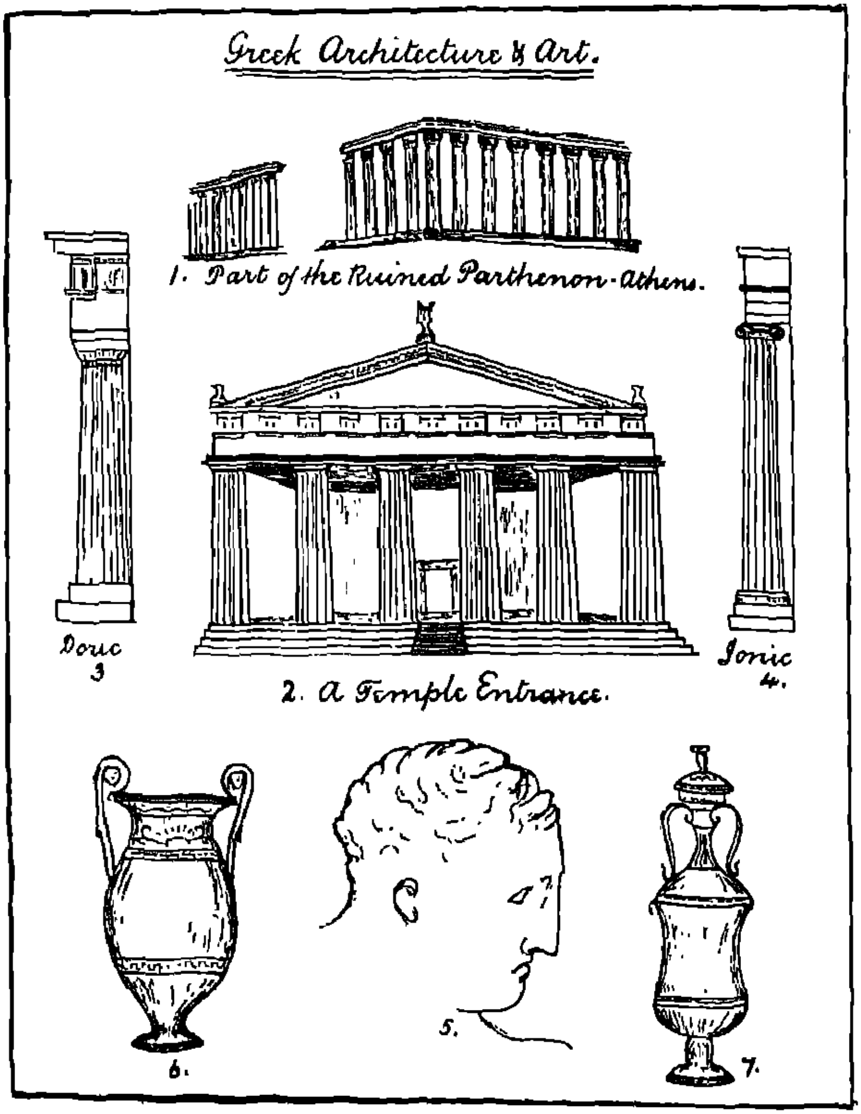


FIG. 50

This time Pisistratus kept a small army of hired soldiers which made it impossible for his foes to overthrow him He governed the city so well that the Athenians settled down happily under his rule.

along the road. He called out to them and offered them food and drink in the usual hospitable Greek way. These men were searching for some one to help them against their enemies who dwelt to the north of them. They

asked Miltiades to be their champion, because the oracle of Delphi had bidden them invite the man who first offered them entertainment after they left his shrine. Pisistratus was pleased that the Athenians should extend their influence northward. He thus proved himself one of the founders of the Athenian Empire.

Pisistratus was a lover of poetry. The two greatest poems in the Greek language, the Iliad and the Odyssey, had been written long since. It used to be thought that they were composed in their entirety by Homer, a blind poet, but as a matter of fact they were composed by many different bards. There were, at the time of Pisistratus, different versions of the poems. Pisistratus did a great service to the Greeks and to all lovers of literature when he persuaded some learned Athenians to fix the text of the Iliad and the Odyssey and write them down.

Before the time that Pisistratus was tyrant the Athenians had celebrated every four years the Panathenaic Festival, but he made it a much more important occasion. There were horse races, gymnastic sports, and musical contests, the prizes for which were wreaths of wild olive and jars of oil. There are preserved jars decorated with black figures representing the warrior-goddess Athene, or men running, and bearing the inscription "I am one of the prizes won at Athens." The most important feature of the feast was the great procession which wound its way up to the temple of Athene, called the Parthenon, which stood on her hill, the Acropolis, to offer her a rich saffron-coloured robe woven by Athenian maidens.

It was Pisistratus who began a mighty temple for Zeus in the plain, but it was too vast for him or his sons to complete. More important than this was the temple that he had built in honour of the god Dionysius

Pisistratus founded a new festival in honour of this god, called the Greater Dionysia of the city. One of the chief features of the feast was a chorus of men dressed as satyrs who danced round the altar clad in goatskins and sang the goat song. It became usual for the leader of the dancers to separate himself from the others and speak to them, assuming the character of some person and wearing an appropriate dress. Various Athenian writers composed a poem for the occasion and trained a chorus of dancers The best chorus was awarded a prize, a tripod, which was set up as an offering to the god in the Street of the Tripods in Athens. Out of these poems and dances developed the plays for which Athens was, and is, famous.

After a long and prosperous reign Pisistratus died and Hippias, his elder son, ruled.

Hipparchus, the new tyrant's brother, had a grudge against Harmodius, one of the Athenians and, to punish him, Hipparchus invited his sister to carry a basket in the Panathenaic Festival, and then publicly refused to allow her to take part in the procession. Enraged by this insult, Harmodius and his devoted friend Aristogeiton resolved to kill Hippias and Hipparchus on the occasion of the Panathenaic procession, when all the Athenians would be present in arms and would, therefore, be able to help if so minded.

On the day Harmodius and Aristogeiton set out, their daggers concealed in the myrtle boughs which it was the custom to carry in the procession. They found Hippias arranging the citizens in order, but, seeing him engaged in friendly talk with one of their fellow conspirators, they imagined their plan was revealed.

They rushed off, found Hipparchus and slew him Harmodius was surrounded and killed at once. Aristogeiton escaped for the moment, but was afterwards captured and put to death. Nothing, therefore, came of the conspiracy except that Hippias, because he was afraid, became a cruel tyrant.

There was, however, one family in Athens that longed to rid the city of Hippias, and they bribed the priests of the Delphic oracle to aid their cause. Whenever the Spartans came to consult the oracle they met with the same answer "Athens must first be liberated." At length the Spartan King attacked Hippias, and captured his children. To regain them Hippias went into voluntary exile. So ended the tyranny, and Athens became a free state.

The Athenians made a drinking song about their freedom—

In a wreath of myrtle I'll wear my glaive (sword)
Like Harmodius and Aristogeiton brave,
Who, striking the tyrant down,
Made Athens a freeman's town.

LUCIUS QUINCTIUS CINCINNATUS

About four hundred and fifty years before Christ was born a Roman named Lucius Quinctius, nick-named Cincinnatus because he had curly hair, lived on his own little farm not far from Rome. He had once been made Consul for a year, but when the Romans wanted him to continue to be their ruler for the next year

FIG. 51

Cincinnatus put on the Toga and turned to the Senators

he refused and went back again to the farm that he loved.

One day he was busy ploughing with his wooden plough drawn by oxen when in the distance he saw some men approaching. When they came nearer he saw that they were wearing white woollen togas with a purple border, and he knew by the purple border that they were Senators. He approached them respectfully, Senators being very important Romans.

Then he turned to the boy who was guiding the oxen and said, "Hasten home to your mistress: ask her for my toga, and bring it back quickly to me." He would have thought it lacking in respect to the Senators if they talked to him when he was wearing the short tunic that he wore when he was busy about the farm.

When the lad returned, Cincinnatus put on the toga and turned to the Senators. They told him grave news. They said that the Aequians, the enemies of Rome, had captured the Roman general and the whole of his army, and that only five horsemen had managed to escape to bring the news of the catastrophe to Rome. The enemy were not far from the city, and there was nothing to prevent them capturing it.

The Senators added that there had been a hasty meeting of the Senate, as the Roman Parliament was called, and all had agreed that there was only one man who could save them in this crisis, and he was Lucius Quinctius. He, they all knew, had previously shown that he was capable of this. They therefore asked him to become Dictator, which meant that every one must obey his commands without question.

Without wasting words Lucius Quinctius and the Senators went to Rome. Lucius Quinctius' first order was that all the shops should be shut and that every man should come at nightfall, each with twelve stakes and with food for five days. The place of meeting was the Campus Martius, the drill ground outside the walls of Rome

At nightfall all the Romans assembled, each with such armour and weapons as he had. Lucius Quinctius explained his plan of action. He told his hastily gathered soldiers that they must encircle the Aequians, who were guarding their prisoners, so quietly that the Aequians should not suspect their presence.

They set out in haste, and by midnight had reached the place. In silence they made a circle round the Aequians. Each soldier, carrying out Lucius Quinctius' instructions, dug a trench in front of him, joining it to the trench of his neighbours. Out of the earth from the

trench they made a mound and on top of this each planted the twelve stakes he had brought with him.

When this was done Lucius Quinctius ordered them to shout all together as loudly as they could. When the captive Romans heard the shout they took courage once again for they knew that friends had come to rescue them. They attacked the Aequians, who, being taken unawares, began to flee. Quickly they came to the trench, the stakes, and the other Roman army under Lucius Quinctius. Then they too engaged in the fight, and the Aequians, being attacked on all sides at once, saw that there was nothing for it but to surrender.

Then the Romans, to show the Aequians that they were conquered, made them pass under the yoke. They made the yoke by setting up two spears and binding a third across their handles. Then all the Aequians passed under these spears. This was a ceremony to which the Romans always made their defeated foes submit.

Great was the rejoicing among the Romans. The captives were full of happiness to be free again, and Lucius Quinctius' men were proud of their victory, and all praised the wit of Lucius Quinctius who had thought out this successful plan. Whatever he had asked, the Romans, in gratitude for their freedom and the safety of their city, would have given him. There was nothing, however, that he wanted. He had only done his duty, as a Roman citizen should. He went back once again to his little farm outside Rome.

[The telling of this story may well be followed by its dramatization. A toga can be improvised out of a sheet and spears out of walking sticks.]

HANNIBAL (247–183 B.C.)

One day in the year 238 B.C. Hamilcar Barca, the best general of the Carthaginians, was offering sacrifice to the gods before going to Spain. He called his nine-year old son, Hannibal, and asked whether he wanted to go to war too.

"Yes," said Hannibal.

"Then lay your hand upon the sacrifice," said Hamilcar, "and swear that you will never be a friend of the Roman people."

"I swear," said the boy, "that I will never be a friend to the Roman people." That oath decided his life work.

Why should Hannibal the Carthaginian be hostile to the Romans? There was bound to be enmity between the two peoples, between the Romans whose might was steadily increasing owing to their skill in fighting, and who by this time had made themselves masters of Italy, and the Carthaginians who, by reason of their fleet, controlled the trade of the Mediterranean, and were exceptionally wealthy. One of them must be mistress of the Mediterranean; the question was, which? When Hannibal made his vow one round of the struggle had already been fought out with Rome as the victor, and there was a nominal peace, but in such a struggle there could be no lasting peace till one side or the other was conquered.

Hannibal from his childhood's days was used to camp life. He was trained from boyhood under the eye first of his father and then of his brother-in-law. He displayed talent of a very high order for both warfare and diplomacy, and he had a character which endeared him to all he met. On the death of his brother-in-law it was only natural that Hannibal, a youth of twenty-six, should be acclaimed commander-in-chief by the Carthaginian forces in Spain. Thus he had the chance of fulfilling his vow.

After two years spent in subduing the remaining Spanish tribes, Hannibal decided that the time had come to invade Italy. He had no fleet comparable to that of the Romans, and so had to make his attack overland. He took with him about ninety thousand infantry, twelve thousand cavalry, and thirty-seven elephants. He reckoned that when he got to Italy he would gain help from the Gauls and from the Italians whom the Romans had subdued, and that thus his victory would be assured.

With these thoughts in his mind he eluded the Roman army stationed in Spain, and got safely through the eastern passes of the

Pyrenees. He made friends with the Gauls in the South of France, for he was determined not to fight more than was necessary before he reached Italy. Then came the difficulty of crossing the swift river Rhone on the far side of which was a hostile tribe of Gauls. Hannibal sent some of his troops to cross farther up the river under cover of night. Next morning he and the remainder of his men crossed the Rhone in hastily improvised boats. The Gauls attacked, but were taken in the rear by the soldiers who had crossed farther up, and fled helplessly.

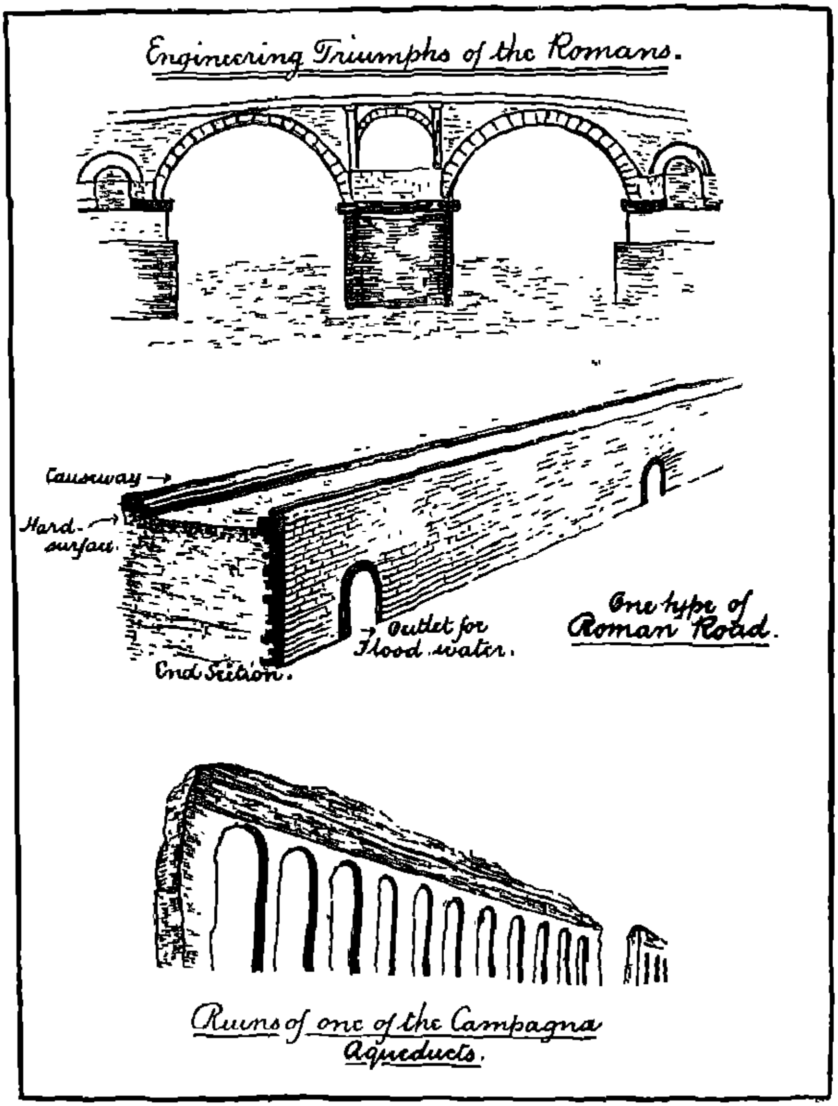


FIG. 52

Hannibal then came to the foot of the snow-clad Alps. Some guides who had promised to show him an easy route led him into a difficult place where savages attacked him, but were at last beaten off. After nine days of terrible

climbing the army reached a plain on the summit of a ridge of the Alps. The ground was covered with snow, and it was bitterly cold, but Hannibal heartened his men by pointing out the sunny plains of Italy below.

The descent proved even more difficult than the ascent. At one place an avalanche had carried away the road and a fresh road, suitable for the passage of elephants, had to be constructed over hard rock. This crossing of the Alps was one of the most memorable achievements of any military force of ancient times. Though it was a sadly diminished army that arrived in the north Italian plain, Hannibal, by crossing the Alps, had forced the Romans to fight out the issue in their own country, and not, as they would have preferred, on foreign ground.

Hannibal in battle proved irresistible. He won one battle at the River Ticinus (218 B.C.), another at the River Trebia, and then he determined to strike for Rome. His great gift as a general lay in his capacity to read the opposing general's mind. He guessed that, if he headed straight for Rome, the Roman general Flaminius would hasten with all speed after him and that, if a trap were laid, he would march heedlessly into it.

Accordingly, Hannibal's men marched beside Lake Trasimene, and then closed the exit between the end of the lake and the mountains. Others took up their position on the heights above, where they were hidden from sight by a fog. Flaminius' men marched beside the lake.

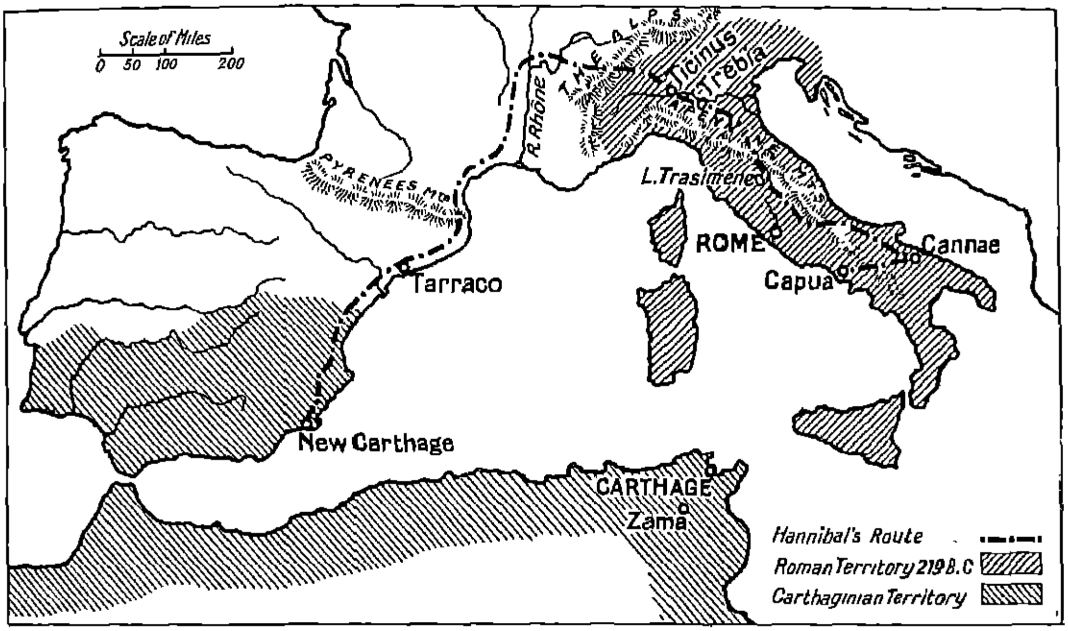


FIG. 53

The War between Rome and Carthage

Some of the Carthaginians immediately cut off their retreat· others barred their advance: the rest came down from the heights and the entire Roman army was destroyed or captured (217 B C.)

The Romans in these straits appointed a Dictator, Quintus Fabius Maximus He had not to defend Rome itself, for Hannibal decided that he had not sufficient siege engines to capture Rome, and he therefore marched on into southern Italy. Fabius resolved not to tempt fortune by another pitched battle, and, despite the provocation of Hannibal, who devastated the country before his eyes, and despite the

impatience of his own officers, he persistently followed the Carthaginians from place to place, cutting off stragglers here, capturing a baggage train there, intent on gaining time for Rome to recover. For this he was nick-named "The Footman" and "The Cunctator" (The Delayer).

In time the Romans grew tired of this sound but dull strategy, and appointed fresh generals. They quickly justified Fabius' wisdom by allowing Hannibal to inflict such a defeat on the

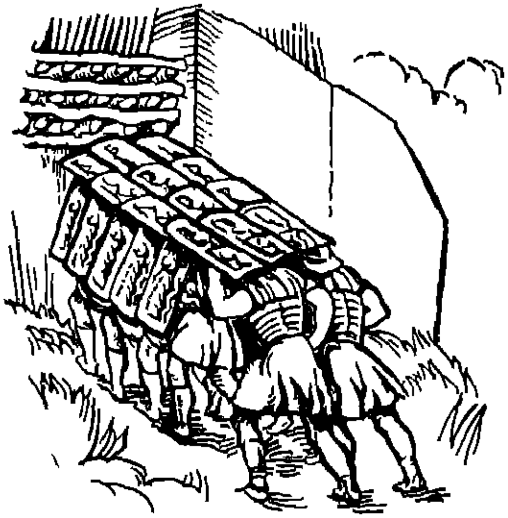


FIG. 54
Roman Soldiers Attacking Fortifications under their Interlocked Shields

Roman army at Cannae as it had never before experienced (216 B.C.).

With any other foe Hannibal might have counted after this on making a successful peace, but the Romans, like ourselves, never knew when they were beaten and returned to Fabius' tactics. Hannibal, too, had lost many men and got no recruits from home. He was disappointed that very few of the Italian tribes subdued by the Romans made a bid for freedom by going over to his side. The town of Capua and Syracuse which went over were recaptured by the Romans after a long struggle.

After this came a time of stalemate: the Romans could not drive out Hannibal, and Hannibal could not conquer Rome. At one time Hannibal's hopes rose, for his brother Hasdrubal marched with reinforcements from Spain by the same route that Hannibal had used. The two Roman generals were in the south watching Hannibal. They intercepted a messenger bearing the news that Hasdrubal intended to join Hannibal, whereupon one went north and defeated Hasdrubal at the Metaurus River (208 B.C.), while the other kept up an appearance of controlling the whole Roman army. The first information Hannibal received of the defeat at the Metaurus was the head of his brother flung by the Romans into the Carthaginian camp

One young Roman, Publius Cornelius Scipio, saw that the only way to rid Italy of Hannibal was to attack Carthage. The older men thought him a hare-brained youth, but he appealed to the young men, gathered a force of volunteers, conquered Sicily, and then set sail for Africa. In course of time he was so successful there that the Carthaginians sent to Hannibal to return to defend his native land Hannibal, though he had been neglected by the Carthaginians, returned home at the call of duty but was decisively defeated at Zama (202 B.C.)

Hannibal, however, never forgot his oath of hostility to the Roman people He devoted himself to reviving the power of Carthage at home with so much success that seven years later the Romans sent ambassadors to demand his surrender. He then fled to the court of Antiochus of Syria and offered his services for the war he was about to wage against the Romans. He urged Antiochus to make himself the centre of a great coalition against Rome, but the scheme was too big for Antiochus, who in 190 B.C. was forced to make peace with Rome and agree to give up Hannibal.

Hannibal, again forced to flee, took refuge with Prusias, King of Bythinia, and was victorious for him against one of Rome's allies in Asia Minor, but again the Romans were successful and demanded his surrender. Hannibal, finding that Prusias could not defend him, took poison, which he had long carried about with him in a ring, sooner than fall into the hands of the Romans (183 B.C.). So died the best general that the Romans ever encountered, faithful till death, through success and failure, to the oath of vengeance taken in his boyhood.

THE FIRST CRUSADE

In A.D. 1090 a poor hermit, named Peter, set out from France to go to Jerusalem, on a pilgrimage, that he might worship at the places where Our Lord lived when He was on earth. On his arrival Peter was badly treated by the Turks, who ruled over the Holy Land at that time. He learnt from the Christians there that his sufferings were usual, and that they could do nothing to stop Turkish cruelty. Peter promised to go back to Europe, visit the Pope, and persuade the Christians of western Europe to give them help.

The Pope, Urban II, listened to Peter's story, gave him his blessing, and told him to stir up the people of southern Europe in the cause. Peter, thin and short, dressed in a coarse cloak, with head and feet bare, holding a great crucifix in front of him, gathered a crowd in every village he passed through, and told of the sufferings of the Christians in the Holy Land. All were eager to help.

Meanwhile Alexius, the Eastern Roman Emperor, asked help from Urban II against the Turks. Alexius was afraid that the Turks might capture his capital, Constantinople It seemed to Urban that the best way to help Alexius was to stir up Christians to capture the Holy Land from the Turks.

Accordingly, in 1095 the Pope summoned a Council at Clermont in France, to which came many bishops and knights. To them Urban preached.

"Were they spending their days in empty quarrels, shearing their brethren like sheep? Let them go forth and fight boldly for the cause of God. Christ Himself would be their leader as, more valiant than the Israelites of old, they fought for Jerusalem A goodly thing would it be for them to die in that city, where Christ for them laid down His life. Let them, as valiant knights, descendants of unconquered sires, remember the vigour of their ancestors and go forth to conquer or to die."

"Deus vult, Deus vult!" ("It is the will of God!") the crowd shouted, deeply moved.

Crowds of bishops and knights at once pressed forward to take the red crosses that had been prepared. It is from these crosses that the campaign took its name of Crusade.

Some enthusiasts, men and women, went all unprepared to the East with Peter as their leader, but these could do nothing against the warlike Turks.

In August, 1096, the first great army of the Crusaders began to march toward the East under the command of Godfrey of Boulogne, and his brothers, Eustace and Baldwin.

A contemporary has written: "Godfrey was of a beautiful countenance, tall of stature, agreeable in his discourse, of excellent morals,

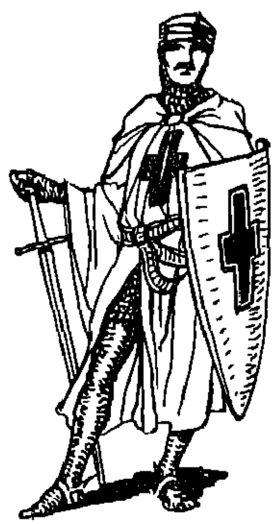


FIG. 55
A Crusader

and at the same time so gentle that he seemed better fitted for the monk than for the knight. But when his enemies appeared before him, and the combat was at hand, his soul became filled with a mighty daring, like a lion he feared not for his own person, and what shield, what buckler, could withstand the fall of his sword?"

On foot they marched through Europe, following the course of the river Danube. At last they reached Constantinople, Alexius' capital, after many mishaps and much fighting.

They found that Hugh of Vermandois, the headstrong brother of the King of France, and

Robert of Normandy, the brother of William the Conqueror, had already arrived.

The third army to reach Constantinople was under the command of Bohemond, Prince of Tarento in south Italy, a bold and skilful leader in warfare, but mean and crafty.

The last to arrive was Raymond, Count of Toulouse, a man already over fifty years of age. Alexius' daughter wrote of him: "Of the Crusaders Count Raymond Alexius loved in a special way, because of his wisdom, sincerity and purity of life: and also because he knew that he preferred honour and truth above all things."

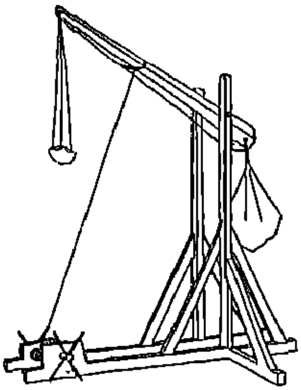


FIG. 56
Siege Engine

Together these leaders and their bands left Constantinople and crossed to Asia Minor. The horsemen wore coats of mail with pear-shaped shields, each with its own device, and carried a long spear and short sword or battle-axe. The foot soldiers bore the cross-bow or long-bow with sword, lance, and buckler. They wore thick pieces of cloth fastened together with rings so as to resemble dense coats of mail.

They attacked the city of Nicaea with good hope of success, but at last found themselves outwitted by the crafty Alexius, who made terms with the Turks and so won the city for himself.

Shortly afterwards the Crusading army divided. The Sultan, realizing that this gave him a great advantage, threw himself on the forces of Robert of Normandy. The Turkish numbers were overwhelming, and, had it not been for Robert's courage, all would have been lost before the other half of the crusading army, hastily summoned, appeared. The Turks fled before the united host.

The Crusaders then made their way to Antioch. On the way they had to cross practically desert land under the broiling July sun. They were tortured by thirst and famished, for the Sultan had given orders that all food supplies should be destroyed.

The tired troops laid siege to Antioch, but it seemed quite impossible for them to capture it. At last Bohemond suggested that the leader who succeeded in taking the city should be its ruler. The rest reluctantly agreed. Then the crafty Bohemond, who had already bribed traitors within the town, captured it.

Following upon this the enemy shut up the Crusaders in the city. They were almost in despair when a priest burst into the consultation of the leaders saying that he had had a marvellous vision. In his dream St. Andrew had carried him to the Church of St. Peter in the city, and shown him the head of the lance that had pierced Christ's side. This, the Saint had told him, if carried at the head of the army, was certain to bring victory.

That evening the Crusaders, after a long search, found the lance head where the priest had said it would be. They were once again confident of success. Carrying the lance they attacked the Turks, and, though they were far fewer in number, they won a great victory.

The crusaders could not at once set out for Jerusalem, their goal, because of the summer heat. Not till January, 1099, did they march out, leaving Bohemond as Governor of Antioch. At dawn of June 7, they watched the sun rise upon the sacred walls of the Holy City.

"Jerusalem, Jerusalem!" they said in awed tones as they knelt.

Full of hope they laid siege to it, but for some time they could not take it. At length Peter the Hermit affirmed that the city would fall if the army marched barefoot round it every day for nine days. On the fourth day following the Crusaders managed to make their way into the city. Jerusalem was won

The Crusaders signalized their victory by

killing all the Turks in Jerusalem, believing that in this way they would please God. Immediately afterwards they walked, bareheaded and bare-footed, dressed in long white mantles marked with the red cross, to the Church of the Holy Sepulchre to offer thanks for their success.

A week later the leaders agreed that Godfrey of Boulogne should be King of Jerusalem. Characteristically, he refused to wear a crown of gold where Christ had worn a crown of thorns, and so he took the title of "Defender of the Holy Sepulchre."

Thus Jerusalem was rescued from the Turks, and pilgrims could go in safety to the Holy City.

Conclusion

Naturally the Turks did not give up the Holy Land without a further struggle. For two hundred years fighting continued between the Moslems and the Christians. Whenever the Turks were particularly successful in defeating the Christians in the Holy Land, Christians in Europe organized a great expedition to recover the ground which had been lost. There were eight such expeditions, each of which was called a Crusade. One of the leaders of the Third Crusade was Richard Coeur de Lion, King of England. (For details about this and other Crusading matters see "The Ivanhoe Frieze," page 682.) At last in 1291 the Christians were driven from the Holy Land, which remained in the hands of the Turks till it was recovered by General Allenby in the Great War of 1914–18.

By courtesy of FIG. 57 *The British Museum*

Ewer, in the Form of a Knight on Horseback, English, 1300

At this time a ewer and basin were carried round after a meal by servants, that those at table might rinse their fingers

ST. FRANCIS OF ASSISI

St. Francis was born about 1182 at Assisi in central Italy. His father, Pietro Bernardone, was a wealthy cloth merchant who travelled far and wide to sell his wares. Pietro wanted his son to get on in the world and so gave Francis plenty of money to spend and encouraged him to associate with those who were better born than himself. Francis flung himself into this gay life with that whole-heartedness that characterized everything that he did.

When Francis was about twenty-two years old he fell seriously ill. One day when he was getting better he went out for a walk into the country, and there suddenly realized the miserable emptiness of his life. When he got well again, however, he went back to his old ways, perhaps to drive other thoughts out of his mind.

Shortly afterwards a noble was departing for the wars, and Francis fitted himself out sumptuously to accompany him, assured that

he would return a young prince. They had no sooner started than Francis fell ill of a fever, and they returned to Assisi. A change came over him. Neither work nor play enthralled

FIG. 58

St. Francis and the Birds

him, but he took long country walks and thought about religion His friends tried to win him back to their ways, but in vain.

About two years later, one day at the turn of a lane he found himself face to face with a leper. This disease had always filled him with loathing. Without stopping to think, he turned his horse in another direction. Then he realized what he had done. He, who was trying to be the knight of Christ, had shown himself, by turning away from a leper, to be a coward. He went back, gave the leper all the money he had, and kissed his hand.

There was one church, that of St. Damian, which Francis often frequented, the sole adornment of which was a crucifix. One day Francis was praying there, "Be found of me, Lord, so that in all things I may act in accordance with Thy holy will," when the Christ seemed to come to life and to speak to him, assuring Francis that He needed him. Francis' first idea in his joy was to repair the church. He went home, collected a few possessions, sold them, and returned to give the money to the priest of St. Damian's for the restoration of the church.

Francis' father, finding that his son did not return, went with his neighbours to search for him. Francis knew that his father could not understand or approve of the change that had come over him, and that in consequence he would be violent. So Francis went and hid himself. A few days later he saw that his course of action was cowardly, and he went to explain to his father what he had done. He was so altered in looks that the children called after him as a madman. Pietro, feeling himself disgraced, pushed his son into a room and kept him locked up. While Pietro was away from home, however, Francis' mother, who loved him, released him.

Finally, Francis was brought before the Bishop, who advised him to give up his possessions. Thereupon Francis stripped himself of his clothes, laid down the little money he had, and said, "Until this time I have called Pietro Bernardone my father, but now I desire to say nothing else than 'Our Father, Who art in Heaven.'"

A little later, when St. Francis was in church, he heard the priest read the Gospel: "As ye go, preach, saying, 'The Kingdom of Heaven is at hand.' Heal the sick, raise the dead, cleanse the lepers, cast out devils; freely ye have received, freely give. Provide neither silver nor gold nor brass in your purses, neither scrip, nor two

coats, nor shoes, nor staff, for the labourer is *worthy* of his hire." Francis resolved to take these words as his rule of life

Men were attracted by the simplicity of St. Francis, and came to offer to live as he did. The first was Bernard, a rich man of Assisi. Francis said that he must sell all his possessions and give the money to the poor. Others joined these two At first they had no fixed abode. They built huts to live in, wore the coarse brown tunics of the Italian peasants, wandered about in twos and threes, slept in hay-lofts, or in the open air, preached, and looked after those who were ill, begging their bread.

When there were twelve friars (brothers) as Francis and his followers called themselves, Francis thought that he ought to write down a rule of life according to which they should live, and ask the Pope to sanction it. At first the Pope thought that the rule proposed by St. Francis was too hard for men to follow, but after some persuasion he agreed to it.

More and more Friars joined the order until at last they were to be found in all the countries of Europe, and also in Syria, and everywhere they were welcomed because they were always happy, and because they were kind to all that were in trouble.

As more friars joined the order, and as St. Francis became more frail he felt himself unable to act any longer as Minister General of the Order. He therefore called together all the friars and said: "Lord, I give Thee back this family which Thou didst entrust to me. Thou knowest, most sweet Jesus, that I have no more the power and qualities to continue to take care of it. I entrust it therefore to the Ministers."

St. Francis had an abounding love for all the objects of Nature. The sun he called his brother, the moon his sister. One day he saw a small flock of birds and walked toward them. Instead of taking flight in fear at his approach they flocked round him "Brother Birds," he said, "you ought to love and praise your Creator very much. He has given you feathers for clothing, wings for flying, and all that is needful for you. He has made you the noblest of His creatures; He permits you to live in the pure air; you have neither to sow nor reap, and yet He takes care of you." Then the birds began to spread out their wings, to open their beaks, to look at him as if to thank him, while he went up and down in their midst stroking them with the border of his tunic, and sending them away at last with his blessing.

Near the end of his life St. Francis determined to spend some time alone on the mountain of La Verna. A little hut of boughs was made for him, and Brother Leo was told to bring him a little food daily. Francis spent his time meditating on the Passion of Christ, ardently desiring to suffer for Christ and with Him. One day, as the sun rose, a seraph flew toward him. In the centre of the vision appeared a cross, and the seraph was nailed to it. When the vision was over Francis saw that he had the marks of the crucifixion on his body—the mark of the nails in hands and feet, and the wound in the side—and these marks of supreme honour the stigmata, he bore for the rest of his life.

For some time previously St. Francis had been ill, and after he received the stigmata he was more frail than ever. When the doctor told him that he was near to death he said with great joy, "Welcome, Sister Death!" and so went to meet death singing.

MARCO POLO

The most wealthy city in Europe in the Middle Ages was Venice, because her citizens were merchants who travelled in their ships to the east of the Mediterranean and brought there from the merchants of the Far East jewels and spices. These they brought to Venice, and then carried them by sea or overland to all parts of western Europe, bringing back money and goods in exchange.

In the thirteenth century there were two brothers, Nicolo and Maffeo Polo, jewel merchants of Venice, who in 1254 set out for Constantinople. Years passed and they did not return, so people naturally concluded that they were dead.

After fifteen years, however, they returned to their home, but they were so much altered that at first no one recognized them Exciting was

the story that they had to tell They had reached Constantinople and bought jewels, as was their custom, but then, instead of returning to Venice, they had sailed to the Crimea.

In those days few Europeans travelled as far as the Crimea, and practically none ventured beyond. The Polos, however, journeyed overland into the realm of the Tartars, a wonderful race who had in the last fifty years built up an empire which reached from China to the Danube, and from the Persian Gulf to the south of Siberia.

The Polos were welcomed by one of the Tartar rulers, and after a year's stay they decided to explore still farther east. They stayed for three years in the city of Bokhara, a town famous for its beautiful silks and brocades.

At the end of the three years it happened that some Persians came to Bokhara on their way to visit the court of the greatest ruler of the Tartars, the famous Kublai Khan, who dwelt at Peking in China. With them the two adventurous merchants journeyed. Never before had Europeans visited the city.

Kublai Khan made them very welcome, and was always anxious to gain information about the European princes, and about the Christian religion. Finally he asked them to act as his ambassadors to the Pope and ask him to send a hundred men to explain Christianity to the Tartars He added that he would wish them to visit Jerusalem and to bring from there some holy oil from the Church of the Holy Sepulchre. He gave them a golden tablet ordering all his subjects to aid them on their journey. After three years they reached Venice.

Such was the tale that the two merchants had to tell, and no one was a more fascinated listener than the fifteen-year-old Marco Polo, Nicolo's son. He had long dreamed of making just such a journey when he grew up, and could not contain himself for joy when he heard that his father and uncle would take him with them on their return to the court of the Great Khan.

After two years delay they set out, but they could find only two friars who were willing to risk the journey, and even they fled before they had gone far. They took with them the holy oil, and made their way through Armenia to Baghdad. From there they passed safely through the desert till they reached the head of the Persian Gulf. From there they sailed to Ormuz, but when they saw the frail little boats which the merchants of that town used in their voyages to India they decided to take an overland route.

They crossed the Pamirs, a very high plateau, which we sometimes call "The roof of the world." Day by day they journeyed on, passing on their way the famous cities of Kashgar and Yarkand. They had a little cart on which they packed all their belongings, including their little round tent made of felt.

One day they saw riding toward them a number of richly dressed Tartars. They had been sent specially by Kublai Khan to escort the brothers on the last part of their journey.

At length they came to Shandu, the summer palace of the Great Khan, a marvellously beautiful building made of marble and coloured stones splendidly carved. Nowhere in Europe was there a palace to match this in beauty.

The merchants knelt before Kublai Khan with their foreheads to the ground, but Kublai quickly raised them, eager to hear of their travels and what messages they had brought him. They presented a letter from the Pope and the sacred oil.

Then the Great Khan noticed Marco, and on his being presented had him enrolled among his honourable attendants. Never had Marco seen so gorgeous a feast as that in the Khan's palace on the night of their arrival, and after the feast the guests were entertained with music and plays.

Before long the Great Khan made Marco his favourite attendant. Often he sent him to distant parts of his Empire because he knew that Marco was very observant and would bring him back a vivid description of all he had seen.

For seventeen years the Polos served Kublai Khan very happily. During this time Marco travelled over much of China, and visited the wonder cities of Suchan and Kinsai, and he travelled as far as India. After so long an absence from their native city the Polos began to long to return to it. When they asked leave of the Great Khan to return to Venice he was very reluctant to let them go.

At this moment fortune favoured them.

There came ambassadors from Persia seeking a princess for their ruler to marry from among the ladies of Kublai's court. The ambassadors found it impossible to take the princess by land because there was fighting in the regions through which they would have to pass, so they proposed to go by sea, if the Great Khan could provide them with some guide who knew the way. No one at the court had travelled so widely as Marco Polo, so he and the two older Polos were allowed to escort her.

They coasted beside China and passed the Spice Islands. They visited Ceylon, and at last, after a voyage lasting two and a half years, reached Ormuz. They handed over the princess to her future husband, and then took the caravan route through Persia and Asia Minor till they came to the Black Sea. From there they sailed to Constantinople, and thence to Venice without mishap.

When they arrived at their home (1295) after an absence of twenty-four years no one recognized them, and they were turned away from their own door because in their travel-stained clothes they looked like beggars. Shortly afterwards they asked their relatives to a banquet. They astonished their guests by putting on in succession three changes of rich clothes, then the old clothes in which they had arrived. To the surprise of all they ripped up the old clothes in which they had arrived, and out tumbled countless precious stones.

Shortly afterwards Marco, who was put in command of a Venetian galley in a battle against the Genoese, was captured While he was in prison he became popular because of the

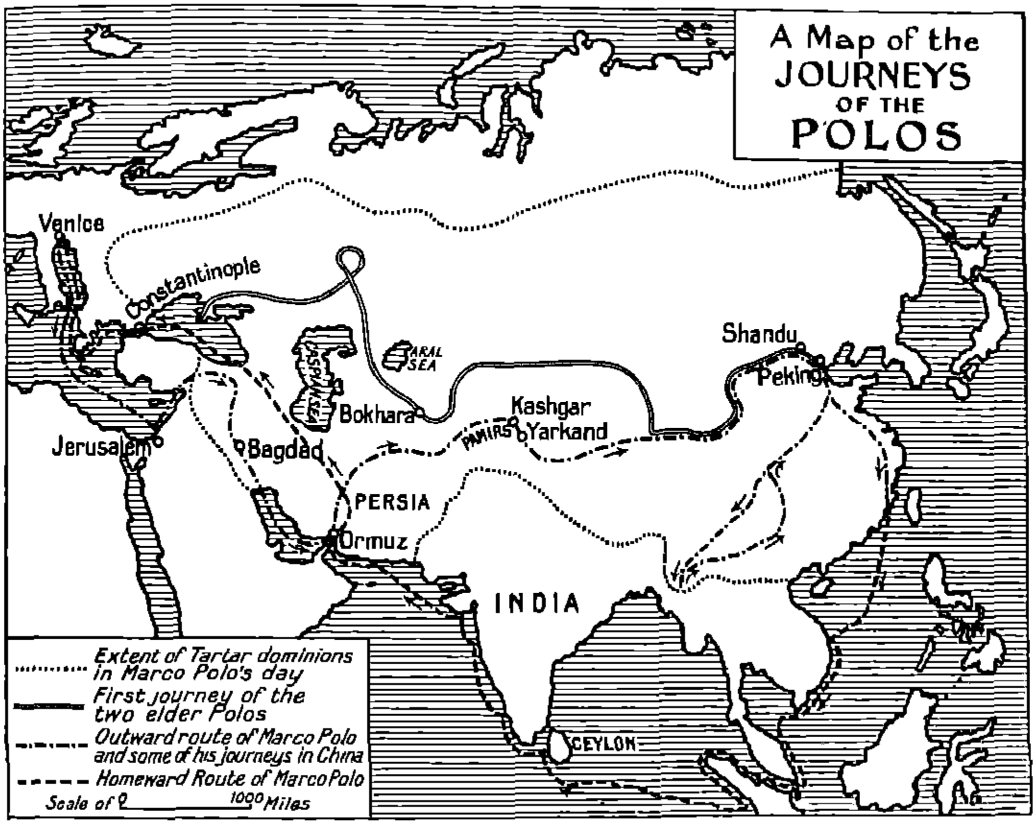


FIG. 59

marvellous stories he could tell of his adventures. He dictated a full account of all that he had seen and done in distant lands, a book which we still have. Some people laughed at the stories in the book, saying that he had made them up, but recent travellers who have made the same journey say that his descriptions are wonderfully accurate.

FIG 60
A Chinese Image of Marco Polo

Marco Polo was the greatest traveller of the thirteenth century. For fifty years after his death Venetian merchants followed the route into Asia that he had traversed, and made themselves rich with the jewels and spices that they brought back with them. Then there was fighting in the East. The Chinese drove the Tartars out, and the Turks pressed on toward Europe. Thus these old trade routes were closed.

In spite of this Marco Polo's influence was not dead. Christopher Columbus, reading his book two centuries later, resolved that he would reach the lands discovered by Marco Polo by travelling west instead of east. He reached America Vasco da Gama, reading his book in the cabin of his ship, reached India, not by Marco Polo's overland route but by sea.

GUTENBERG AND THE INVENTION OF PRINTING

Five hundred years ago books were so dear that only the richest people could afford to buy them, and the man who possessed thirty books was considered to have quite a library. Books were very expensive because, before the invention of the printing press in the fifteenth century, all books were written by hand, which is what we mean when we use the word *manuscript*.

In the days when books were written by hand it took a very long time to make a copy of a book. Just before the printing press was invented a very wealthy man engaged forty-five skilled scribes to copy books, and in nearly two years they could produce only two hundred books.

In the early Middle Ages most of the books were copied by the monks, who were the only people who could read and write with any ease. They sat in little recesses in the cloisters of the monasteries and wrote, using goose-quill pens on parchment. Every letter they wrote beautifully, and they left the capital letters to be filled in later by one of their number who was particularly skilled in drawing. He designed a beautiful capital letter and painted it in bright colours. These manuscripts made by the monks are preserved in museums, and they are among the most beautiful things which remain to us from the Middle Ages.

At the beginning of the fifteenth century came the invention of wood blocks for printing pictures. These pictures were drawn backwards in thick lines on a piece of soft wood. Then the wood between the lines was cut away. The lines, which now stood out, were inked and the picture was stamped on the paper which was by this time replacing parchment Below the picture were a few words to explain it. The printed pictures are called woodcuts By their means it was possible to take off many pictures from one block, and so less time was spent than if the artist had to draw a fresh picture every time one was wanted

Just at the time when these woodcuts were being made Gutenberg was growing to be a man. He was a German born at Mainz, of wealthy parents, in the year 1398. When the lad was about ten his parents had to leave Mainz because there was a quarrel between the wealthy and the poor in the city. They went to live at Strasbourg

When Gutenberg was only a youth of fifteen he was busy making experiments in polishing stones and making mirrors. He needed a partner in the business because he had not the

necessary capital, but he was so clever at the work that he had no difficulty in finding one. For twelve years he and his partner worked together, and then their trade failed because a pilgrimage was postponed. They had made many mirrors in the hope that the pilgrims would buy them, and they could find no one who would buy them instead.

Gutenberg and his partner then set up with two other men as printers of woodcuts, and apparently they did well. Gutenberg, however, was not satisfied with this. He wanted to print words, not pictures. He quickly realized that it would take a long time to carve a page of words in a block of wood, and after much thought it occurred to him that what he wanted was a number of separate letters that could be fastened together into a frame, and which, when sufficient copies of the page had been printed, could be separated and set up again for another page.

To carry out the necessary experiments Gutenberg needed capital. He explained his plans to Fust, a shrewd merchant of Mainz, in which town Gutenberg was once again living. Fust thought the plan so good that on two separate occasions he lent money. As security for his money Fust had a claim on all the printing stock-in-trade.

At this time Gutenberg took into his service a clever worker in metal called Schoeffer. He suggested that Gutenberg, instead of carving all his letters in wood, could save time and expense by carving a letter in metal. With this metal letter he punched a mould in a softer metal. Then he melted metal and poured it into this mould and thus quickly got as many letters as he required.

As soon as this difficulty had been overcome Gutenberg decided on the printing of a copy of the Bible.

It took a long time and the cost was heavy. In 1455, the first printed book, the complete Bible in Latin bound in two volumes, was for sale. People were surprised that it was as clear as though it had been written by hand. When they learnt that many copies had been printed at the same time, and that the cost of a printed copy of the Bible was less than that of a hand written one, they were still more astonished.

Just at the moment of Gutenberg's triumph, the mean Fust came to claim the money he had lent. Gutenberg had spent all on his experiments and on buying the paper for the copies of the Bible, and on paying those who had printed it. If Fust had been willing to wait till Gutenberg had sold the copies of the Bible he would have been paid in full. Instead, sticking to the

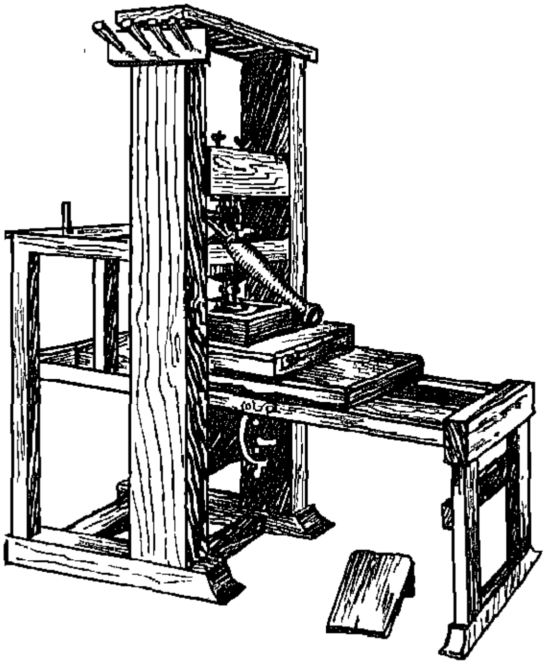


FIG. 61

Caxton's Printing Press

Caxton was the first Englishman to set up a printing press in England—in 1476

letter of his bargain, he seized the printing press.

A friend gave Gutenberg the money to set up another press, and Gutenberg printed one or two more books, but he did not prosper, and ended his days taking a pension from the Archbishop of Mainz

Gutenberg was ruined in the hour of his triumph, but his idea was used, and printing presses were rapidly set up in all the important cities of Europe, bringing great changes to life.

The interested visitors to any of these printing workshops saw a man or two sitting near a window with small boxes in front of them, one box for every letter of the alphabet. Each box contained the type, that is the metal letters. One box had all the f's, and another all the p's. Fixed up near each of these compositors was the manuscript which he was setting up in print. In his left hand he had a stick with a groove in it. Into this he put the letters which he took out of the boxes, and thus made a line of print. When he had filled the groove of the stick he took out the row of type he had made and put it into a frame of wood. Then he filled the stick again and put the row of type into the frame. Thus he continued until the frame was full. Then he fastened the frame tightly together.

Another man then, with leather pads, smeared ink on to the frame of type. Another worker took a clean sheet of paper big enough to cover the frame and to make two pages of the book, and fastened it into what was called a wooden margin. Then the clean paper was shut down on to the inked type and thrust under the press. One of the workmen pulled the lever or handle towards him and thus pressed the paper down on the type. Then the men drew the framework of type and the paper from under the press, unfolded the framework and took out the printed page.

When enough copies of these two pages had been made the frame was taken out of the press, the type taken out and the compositor set up another two pages. This was continued until all the pages had been printed.

Often books were bound in the same workshop and sold by the printer.

VASCO DA GAMA AND THE SEA ROUTE TO INDIA

In Portugal nearly six hundred years ago there lived a great Prince called Henry the Navigator. He gained this name not because he went to sea himself, but because he was

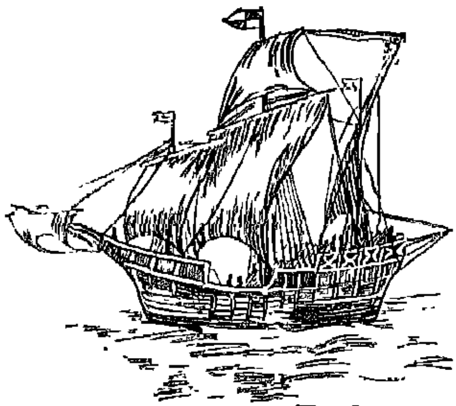


FIG. 62

The Type of Ship in which da Gama sailed to India

always reading old books of geography and studying old maps and encouraging sailors to explore the west coast of Africa. In those days no one knew what the east and west of Africa were like, though, of course, many sailors were well acquainted with the northern Mediterranean coast

The Portuguese seamen sent out by Henry the Navigator found the Cape Verde Islands, and so named them because they were green while the coast to the north of them was parched and sandy. Others, after Henry the Navigator's death, sailed farther south, but they all returned with the news that the coast of Africa stretched still farther south than they had been able to journey.

At length one of these seamen, Bartholomew Diaz, reached the south of Africa and rounded the Cape. He suffered so much from the terrible winds and currents as he rounded the Cape that he called it the Cape of Storms. When he told his adventures to King John of Portugal he said that if it were called "The Cape of Storms" the sailors would be unwilling to sail past it. He therefore called it "The Cape of Good Hope," because he hoped that Portuguese sailors would reach India that way.

It was in the hope of reaching India by sea that so many Portuguese sailors had risked their lives. From India Europeans wanted pepper, nutmegs, cloves, and spices, to make

the salted meat that they had to eat in winter more palatable. Since the time of Marco Polo Europeans had been shut out from the overland route to India and China.

This was the state of geographical knowledge when King Manoel of Portugal asked a gentleman of his court, Vasco da Gama, to undertake a voyage in the hope of reaching India.

In July, 1497, the people of Lisbon turned out into the streets to see Vasco da Gama set off First came the richly dressed standard-bearer,

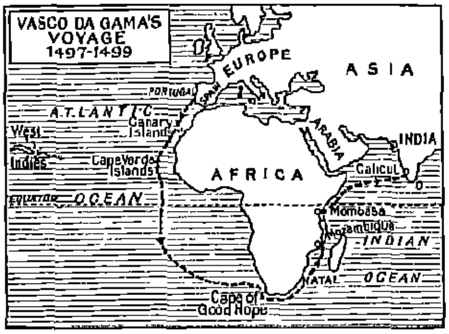


FIG. 63

The Sea Route to India

carrying a silk banner with a golden cross on it. Then came Vasco da Gama, a dark bearded man about thirty-six years old, riding on horseback. Great was the cheering, but there was sadness too, for many feared that he and his companions were going to their death

They went aboard and the four vessels, which had been specially built for the voyage, sailed slowly down the river Tagus. In the cabin sat da Gama looking at his two most precious possessions, a geography book by Ptolemy of Alexandria, who lived about A.D. 150, and a book of Marco Polo's travels

The vessels reached Cape Verde Islands and then da Gama ordered that they should sail due south instead of hugging the African shore, until they reached the Cape of Good Hope. As they were rounding the dreaded Cape a terrible storm arose, and the sailors were so fearful that they begged da Gama to turn back. The storm grew worse, but nothing would persuade da Gama to give up his purpose.

At last they doubled the Cape and found calmer waters. The sailors' hopes of continuous fine weather were, however, dashed by another storm. They crept north beside the eastern coast of Africa, sailing in waters which

FIG. 64

Vasco da Gama

no European had seen before. On Christmas Day they landed on a part of the coast to which, in honour of the day, da Gama gave the name of Natal.

Keeping a northerly course they came to the mouth of a large river up which da Gama gave orders that his ships should sail, since they were in great need of repair. The sailors called it "The River of Mercy," but to-day it is known as the Zambesi River.

After the vessels had been repaired and the sailors had recovered from the scurvy from which they were suffering, as the result of a lack of fresh meat and green vegetables, they sailed north again and put in to a little trading town of Melinda. Here, contrary to their previous

experiences, the king proved friendly and much to their joy lent them pilots to guide them to Calicut in India. For twenty more days they journeyed, and then in the distance da Gama saw the long faint line of the Indian coast. So happy was he that he fell on his knees, spread out his hands to the heavens and was silent.

When they reached the harbour of Calicut da Gama put on his best clothes and went ashore to visit the prince of that part of India. When he was led into the presence of the King of Calicut, resplendent in his jewels, da Gama felt himself but poorly dressed.

He told the King that the great King of Portugal desired peace and friendship with him, and added that if he, and other Portuguese merchants, might take home spices they would give the Indians in exchange many goods from Europe. At first the King was willing, but there were some Arab merchants at hand who wanted to keep the trade in their own hands and they persuaded the Indian prince that the Portuguese were mere nobodies.

At length da Gama set out on his return journey by the same route. This time they had fair weather as they rounded the Cape of Good Hope. Exactly two years and eight months after their departure they reached Lisbon with the holds of their ships full of spices (1499).

Great was the rejoicing in Lisbon. All the citizens crowded into the streets to see da Gama as he went to the King's palace. Da Gama knelt to kiss the King's hand, but the King rose from his chair to make clear to all how much he admired the man who had found the new sea route to India. Titles and money were showered upon him.

From this time forward Portuguese merchants went regularly in their ships to India bringing back spices and jewels, and they never forgot that it was Vasco da Gama who first showed them the way.

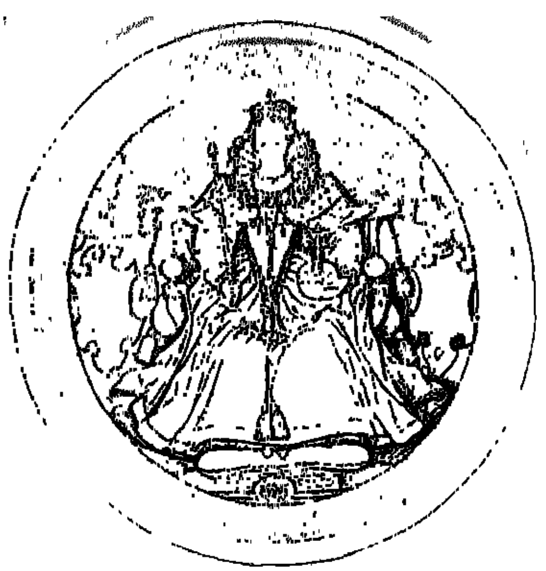
THE FOUNDATION OF THE AMERICAN COLONIES

When in 1492 Christopher Columbus set sail from Spain neither he nor any one else knew that there was a continent stretching from the Arctic Ocean in the north nearly to the Antarctic Ocean in the south, and separating the Atlantic from the Pacific.

When Columbus sighted the West Indies he imagined that he had reached the islands off the coast of Asia. He died in this belief, completely ignorant that he had discovered a new continent, America.

The first English colony, that is, settlement of white men, to be made in what we now call the United States of America was planted at the instigation of Sir Walter Raleigh, famous as the courtier who spoiled his cloak to keep Queen Elizabeth's shoes clean, and as the man who brought back from the New World tobacco and potatoes.

Raleigh showed his wisdom in that he did not expect his settlers to make a fortune by picking up gold and silver, which was what the Spaniards hoped to do in Mexico. He realized that his colonists would have a hard struggle to make a



By courtesy of *The British Museum*

FIG. 65
Queen Elizabeth

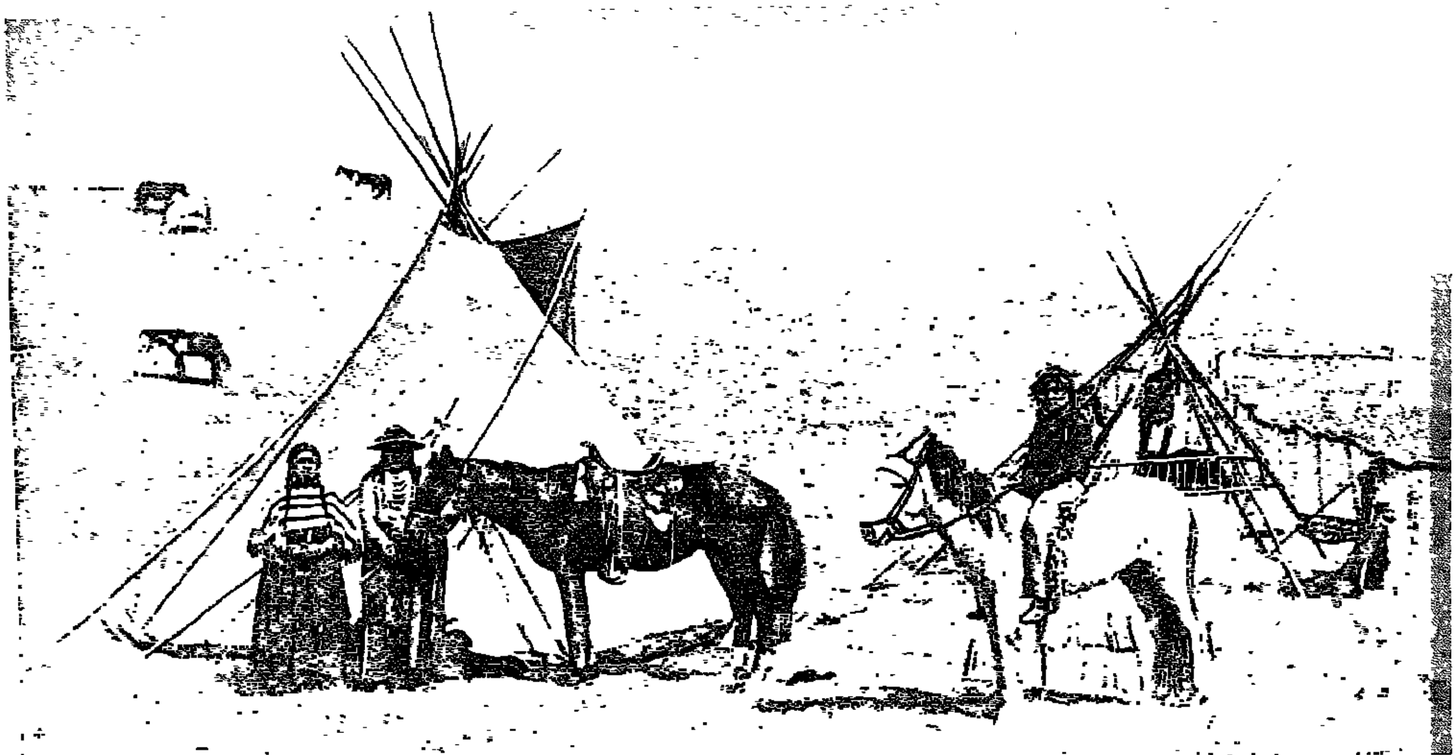


FIG. 66

Mutsinatnakan and Squaw, Sarcee Indians

living by tilling the soil. The colony that, after one or two unsuccessful attempts was founded, he called "Virginia," in honour of Queen Elizabeth—"the Virgin Queen."

The man to whom the success of the colony was due was Captain John Smith. In 1606 he set out with a number of gentlemen and

FIG. 67
Sir Walter Raleigh

carpenters, blacksmiths, and labourers. The gentlemen and Smith quarrelled, and they succeeded in putting him in chains before he reached Virginia.

The party landed on the shores of Chesapeake Bay. At nightfall a party of Red Indians crept up to the little camp on their hands and knees and sent a shower of arrows among the party. The colonists fired their guns, and the Indians, terrified at a sight and sound that they had never experienced before, fled shrieking. At this Captain John Smith was released from his chains, for they knew that he was the best man to help them in emergencies. Shortly afterwards the Indians agreed that the colonists should have some territory in the district.

Captain Smith had a very difficult task to make the gentlemen colonists work at tilling the soil, building houses, and fortifying the encampment, but they found that they must do this to live and, as Smith set them an example by working harder than any one else, they made a success of the colony of Virginia.

Very different were the Pilgrim Fathers, the next settlers in the New World. During Elizabeth's reign some of the Protestants in England criticized the Church of England, disliking the idea of sacraments, ceremonial, and music in church services. They wished to live a very pure life and so were nicknamed "Puritans," a name that stuck to them. (See Fig. 125.)

Finding no sympathy in England from James I, who said that he would make them conform or harry them out of the land, they fled to Holland. After they had lived there twelve years they determined on the great adventure of settling in America.

In 1620, a hundred and twenty Puritans set sail from Southampton in the *Speedwell* and the *Mayflower*. Before they had sailed four days the *Speedwell* sprang a leak and both ships put back into the river Dart for repairs. They set out a second time, but after they had gone about three hundred miles the *Speedwell* was found to be unfit for the voyage and both vessels turned back. Then the *Mayflower* set out alone from Plymouth Harbour.

The *Mayflower* was thirty yards long and eight yards wide, and she carried a crew of fifteen or twenty men. She was fitted with three masts. The hundred and two passengers were cramped together, and the rough seas broke over the vessel. One day the main beam of the ship gave way in the midst of a storm, but one of the passengers with great presence of mind forced back the beam into its place with a jack.

At last, after a voyage of sixty days, on 4th November they landed at Cape Cod. They saw no shelter anywhere, and no sign of man or of food. They had brought with them sufficient food for the journey, and for about another sixty days. In addition they had provided

themselves with a few pea, bean, and other vegetable seeds, a few vessels of wood and pewter, a few carpenter's tools, and the outfit for a blacksmiths' shop. They had no ploughs, no carts, and no harness. It was a pitifully small equipment with which to face the winter in an unknown continent.

They moved inland and saw in the distance some heaps of sand. They thrust their swords into them to find, to their joy and surprise, baskets filled with corn and maize, and a bag of peas, with a bottle of oil. Not far away they came upon a deserted wigwam furnished with bowls, trays and dishes, earthern pottery, tobacco seeds, and rushes for making mats.

A few months later a Red Indian came to

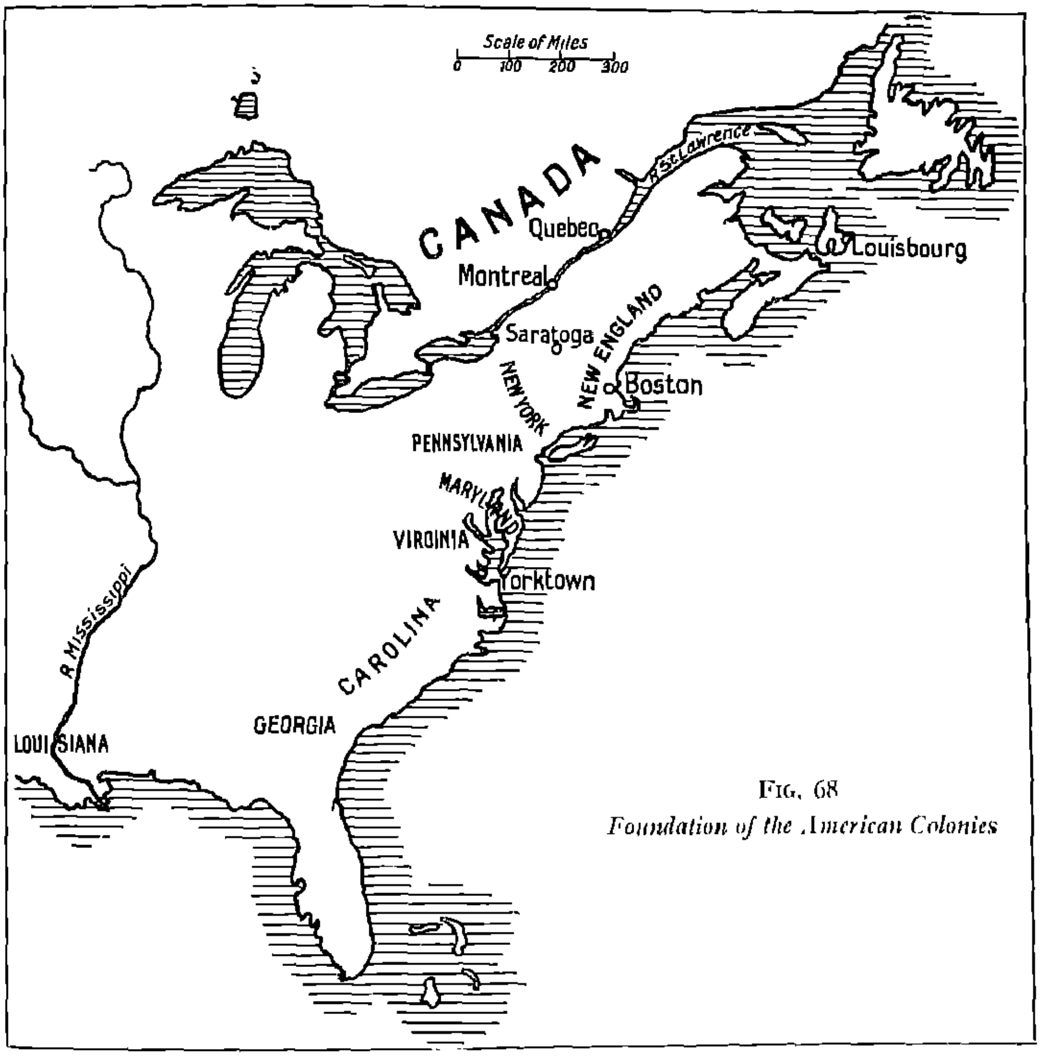


FIG. 68
Foundation of the American Colonies

them, spoke in English about London, and promised them that his chief would be friendly. Two years later the chief fell ill and, when he recovered owing to the attention of one of the party who knew something about medicine, he became their fast friend. In spite of these pieces of good fortune, however, the early years of the New England States were very trying,

and had it not been for the endurance of the Pilgrim Fathers they would have died of starvation or have seized some chance to return to England.

In 1632, Maryland was founded under a royal charter from Charles I. Lord Baltimore, the owner of the colony, was a Roman Catholic, and in his colony Catholics and Protestants lived together in harmony.

In 1681, William Penn, a Quaker, founded another colony. The Quakers, who were also called Friends, believed that all war was wrong. They wore a distinctive dress, the women wearing very sober colours such as grey, while the men refused to take off their broad brimmed hats in the presence even of their social superiors.

King Charles II owed money to William Penn, but instead of paying he granted the Quaker a charter to form a new colony which he named Pennsylvania. Penn and a number of Quakers left England, and soon marked out a place for their first city, Philadelphia, which means "Brotherly Love." Since in this new colony all were allowed to worship God as they thought right, Protestants of various kinds settled here.

Penn was very friendly with the native Indians. He wrote letters to their chieftain, and they met under an elm tree and made a treaty of peace.

New York was conquered from the Dutch in 1665, and became an English Colony.

The last of the colonies to be founded was Georgia (1732). Oglethorpe, touched by the sufferings of imprisoned debtors in England, persuaded Parliament to make a grant of public money to settle them in the New World.

In such various ways the thirteen colonies of Britain were planted in America by men and women widely differing in outlook.

The colonists in the south, in Virginia, Georgia, and South Carolina, grew tobacco and cotton, but the climate was too hot for them to be able to use white labour. Negro slaves, who had been caught on the west coast of Africa, or whose ancestors had been so caught, worked under the blazing sun in the cotton and tobacco fields of the southern states.

In the more northerly of the thirteen colonies there were no slaves. The climate was temperate, the chief occupation was agriculture, and white labour was used for tilling the soil.

This matter of owning or not owning slaves introduced a further difference among the colonists, which was to have serious consequences later.

THE AMERICAN WAR OF INDEPENDENCE

Pitt and Wolfe between them won Canada for Britain (p. 704), frustrating the French hopes of gain in North America. However, the Seven Years' War in which this had been accomplished left Great Britain in debt, and the new Chancellor of the Exchequer, George Grenville, at a loss to know how to raise the money, decided that since the war had been waged for the good of the thirteen colonies, as well as for the benefit of the Mother Country, the colonies should bear part of the expense.

Grenville, therefore, gave orders that the Navigation Laws were to be strictly observed. Now by the English Navigation Acts, the colonists were forbidden to export sugar, tobacco, dyes, and ginger elsewhere than to England or to another colony, and all imported commodities must be shipped from England only. If these laws had been strictly kept they would have very severely handicapped the trade of the colonists, but a great deal of smuggling had gone on without anyone taking notice. Now, Grenville ordered that the smuggling should stop, and that all the import and export duties should be properly paid.

Next, the English Parliament, at Grenville's suggestion, passed the Stamp Act, by which the colonists were obliged to buy stamps to put on newspapers and on small legal documents. At this they were very indignant. They claimed that, as they were not represented in the English Parliament, the Parliament ought not to tax them. Their slogan was "No taxation without representation."

The next year a new minister repealed the Stamp Act, but passed another Act declaring

that the English Parliament was completely justified in taxing the colonists. Feeling grew more hostile in America.

A third minister, Townshend, put a customs duty on tea, glass, lead, and painters' colours. The spirit of the Americans rose higher All the taxes, except the one on tea, were repealed, but the Americans would not be satisfied as long as this one tax remained.

Shortly after this tea ships from India came into Boston harbour. A party of rioters dressed as Mohawk Indians came aboard the ships and threw the tea overboard, and the citizens of Boston, sympathising, refused to punish the rioters for the "Boston Tea Party" as this incident was called. Parliament therefore closed Boston harbour to trade and took other strong measures (1773).

As a result the colonists sent representatives to Philadelphia to discuss what was to be done. This was a remarkable development, for before this time each colony had been very jealous of its independence, and had refused to act with another colony.

A skirmish took place, and George Washington was put in command of the American forces.

Washington was a Virginian, a giant of six feet three, with a commanding presence and with a good record in the Seven Years' War. For the last fifteen years he had lived as a typical Virginian planter of the more prosperous sort. He was a member of the Church of England. He ruled the large number of slaves he held with strictness but also with consideration. It has been said of him—

"Washington was grave and courteous in address; his manners were simple and unpretending; his silence, and the serene calmness of his temper spoke a perfect self-mastery; but there was little in his outer bearing to reveal the grandeur of soul which lifts his figure with all simple majesty of an ancient statue out of the smaller passions, the meaner impulses of the world around him.

"What recommended him for command was simply his weight among his fellow landowners of Virginia, and the experience of war which he had gained. It was only as the weary war went on that the colonists learned, little by little, the greatness of their leader—his clear judgment, his heroic endurance, his silence under difficulties, his calmness in the hour of danger and defeat, the patience with which he struck, the lofty and serene sense of duty that never swerved from its task through resentment or jealousy, that never through war or peace felt the touch of a meaner ambition, that knew no aim save that

FIG. 69

George Washington Reading the Declaration of Independence

of guarding the freedom of his fellow-countrymen, and no personal longing save that of returning to his own fireside when their freedom was secured."

He had need of all these qualities, for when the American army first came together they were without tents or uniforms, and there were not enough cartridges to give nine to every man, and Washington had no money to supply

all these deficiencies. Yet he was criticized by those who wanted him to undertake showy military operations.

On 4th July, Congress composed of representatives from each of the colonies voted the Declaration of Independence

"We hold ..... that all men are created equal; that they are endowed by their Creator with certain inalienable rights; that among these are life, liberty, and the pursuit of happiness, that to secure these rights governments are instituted among men deriving their just powers from the consent of the governed; that whenever any form of government becomes destructive of these ends it is the right of the people to alter or abolish it.

"We therefore, the representatives of the United States of America in General Congress assembled . . . do, in the name and by the authority of the good people of these colonies, solemnly publish and declare that these United Colonies are, and of right ought to be, free and independent states."

In the next year the "Stars and Stripes" became the national flag of the United States, as the colonies styled themselves after the Declaration of Independence. Congress voted that the flag of the thirteen United States be thirteen stripes, that the Union be thirteen stars. As the other states came in to the Union a star was added for each state.

In designing the flag, Washington wanted six-pointed stars, but the widow at whose shop he called showed him that a five-pointed star could be cut by one clip of the scissors, and so the American stars have five points.

In the same year an English general was surrounded by the colonial army and had to surrender at Saratoga. France, seeing that the colonists were likely to win, and anxious to avenge herself for the loss of Canada in the Seven Years' War, entered into the war on the side of the colonists and her example was later followed by the Spaniards.

With this England lost the command of the sea and could no longer be sure of being able to send reinforcements and supplies to the English in America. On one critical occasion Cornwallis, our general, marched into the peninsula of Yorktown, counting on being able to escape with his men by sea. Instead a French fleet, which had for the moment defeated the English fleet, arrived in the harbour, and Cornwallis, who could not escape by sea and whose retreat by land was blocked, had to surrender. When the English minister heard this he threw up his hands and said, "It is all over."

In 1783 peace was signed, and the English agreed to the independence of the United States.

When the Americans had asserted their independence of England they had to decide how they should be governed. They resolved that the United States should be a republic, and elected Washington as first President in 1789. He was elected for a second term of office in 1793. During these eight years he proved himself as great a statesman in peace as he had shown himself in war. After his second period of office he refused to stand as candidate for the Presidency a third time, and gladly returned to the private life which he had reluctantly left when summoned to take charge of the colonial forces. He died in 1799 "first in war, first in peace and first in the hearts of his countrymen."

THE FRENCH REVOLUTION, 1789–1794

In France in 1789 there ruled King Louis XVI, a prince thirty-five years old, who would have made a good country squire, but who was a failure as a King. He cared only for hunting and for working as a locksmith. He was often aptly described as a kind man, but that was only another way of saying that he had no will of his own, but was led hither and thither now by his wife and now by his ministers.

Louis' wife, Marie Antoinette, was a proud and beautiful woman who, when she first came from Austria, her native country, had been full of gaiety, and was often careless of the forms and ceremonies of court life. She had very little understanding of the French people, rich and poor, and because of this she often gave her husband, who at times relied upon her, bad advice.

In attendance on the King and Queen were the French nobility, who wasted their time at the Court of Versailles. There they lived in luxury, spending lavishly on show the wealth that was wrung from their estates in the country.

The Bishops and Abbots of the Catholic Church in France were the sons of the nobility, living pleasantly on the revenues drawn from the lands the Church possessed. The parish priests, poor men themselves, were angry with their superiors for their shameful ways, and sometimes jealous of them for their wealth.

In contrast with the King and the Queen, the courtiers and the Bishops, the country people of France were very badly off. They were ground down by heavy taxation from which the nobility were exempt. What made matters worse was that they never could foresee how much would be required from them in taxes. One of the most foolish and irritating of these taxes was the salt tax. Every one over seven years of age had to buy seven pounds of salt annually. The government had the sole right to sell salt, and made a great profit on it. Again, if a countryman wanted to take or send his goods into another French province he had to pay a heavy customs duty.

Besides all the money that the serfs had to pay to the government they had to pay tithes to the parish clergy and dues to their feudal lords. Often the noble landowner had the right to a certain portion of the peasants' crops. Sometimes he maintained the only mill, wine press, or oven in the district and could require every one to make use of these and give him a share of the proceeds.

The nobles, too, had the sole right of hunting. The game which they preserved damaged the peasants' crops, and peasants were not allowed to kill the deer, hare, rabbits, and pigeons.

The serfs in other parts of Europe were worse off than those in France, but the French were sufficiently alert to resent their sufferings.

If the French had had Parliaments they might have been able to remedy their grievances without a revolution, but no Parliament had been held in France since 1614, a hundred and fifty years before. All power was in the hands of the King and of his ministers, and none dare complain because they could be imprisoned by the King by means of *Lettres de Cachet*, without first having a fair trial.

In spite of the heavy taxes paid by the peasants, Louis XVI was nearly bankrupt One of his ministers advised him that the way to gain money was to persuade the people to consent to new taxes, particularly to persuade the nobles and the clergy to pay taxes. He advised the King to call a States General, as the French Parliament was called. Louis agreed, nor foreseeing what would be the outcome. The voters, every man over twenty-five who was on the taxpayers list, were told to draw up a list of grievances which they had against the government, and of these between fifty and sixty thousand were sent in. The French hoped that the King would remedy all the wrongs and would for the future be guided by the wishes of his people.

The King, however, was not prepared to go as far as his people hoped, and he showed this by dismissing a popular minister. Whereupon Camille Desmoulins, leaping on to a chair in the gardens of the Palais Royal in Paris, shouted, "To arms! Not a moment must be lost! I have just come back from Versailles. M. Necker has been dismissed. To-night all the Swiss and German battalions in the Champ de Mars will come out and slaughter us! We have but one chance left—to arm!"

The answer was thunderous roar. There was rioting that evening and the next day. On 14th July the mob attacked the Bastille, the famous state prison of Paris. It was hated by the citizens as a standing reminder of the power of Kings. The mob stormed the walls, released the prisoners (there were only seven), and massacred the defenders of the Bastille.

The King had been out hunting that day as usual. He was waked out of his sleep to hear the news.

"This is a revolt," he said.

"No, sire, it is a revolution," was the reply.

Three days later Louis, cowed by this outburst of popular fury, recalled the popular minister and rode into Paris, wearing the tricolour, the flag of the revolution.

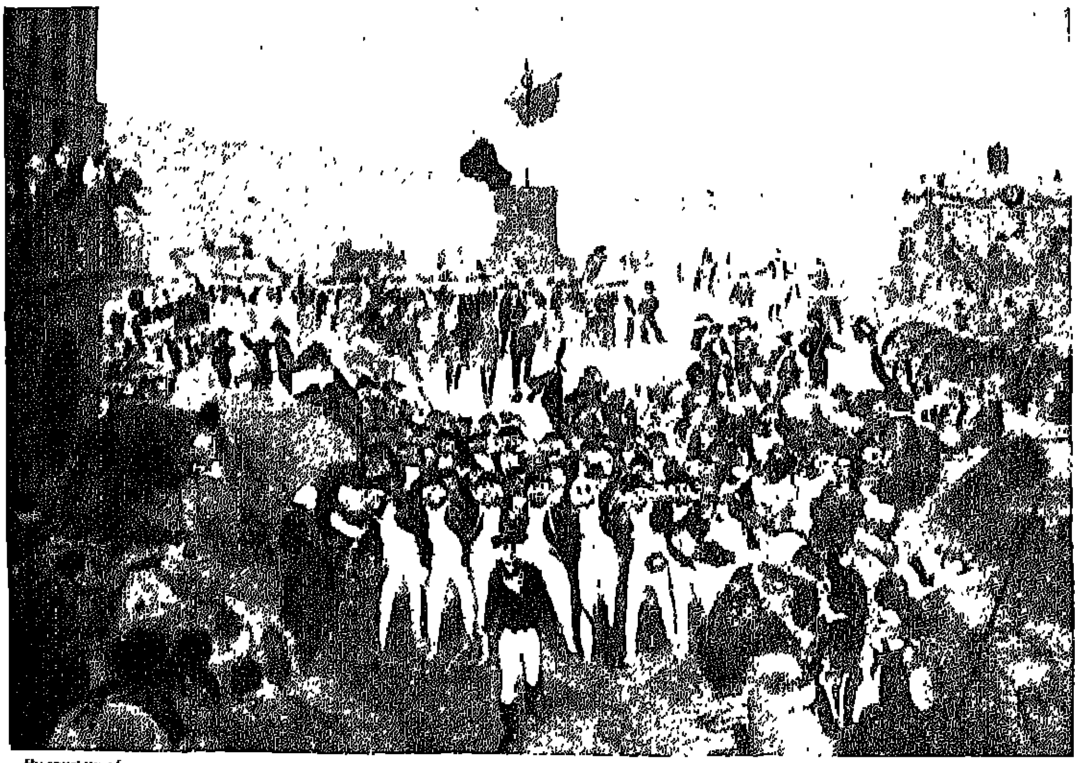
On 4th August, when the deputies were sitting in the Assembly at Versailles, a noble

rose to explain that what made the mobs sack the country houses was their hatred of paying dues to their lords. He proposed that the dues should therefore be swept away. This was followed by wild applause. After this deputy after deputy rose to make a similar suggestion. One proposed that the clergy should give up the rights of their order, another that sporting rights should be resigned. Tithes, financial privileges were likewise given up. "The France of history vanished on 4th August, and the France of the new democracy took its place." The work of that one night has never been undone.

On 26th August, following the American example, the French Assembly issued "A Declaration of the Rights of Man." Significant phrases from it are: "Men are born and remain free, and equal in rights." "No person shall be accused, arrested, or imprisoned except according to law." "Every citizen may speak, write, and print with freedom within the law." Soon news of this document spread all over Europe, and all thoughtful people were discussing "The Rights of Man."

Meanwhile the mob in Paris was starving, and the women determined to march on Versailles to make the King and Queen take up their residence in Paris, believing that where the royal family was there would be bread. These rough women broke into the Palace, and threatened the life of the King and Queen. At length they were quieted by the promise that their Majesties would go to Paris.

The royal coaches moved slowly from Versailles to Paris. The women shouted, "Here



By courtesy of Victoria and Albert Museum

FIG. 70

Crowds in Paris Welcoming the Army in 1793

Note the tricolour flying.

come the baker and his wife and the little baker's boy." The royal family took up residence at the Tuileries.

For awhile Louis, powerless, let events take their course. Then he resolved to flee from his humiliating position. He, Marie Antoinette, and their children drove away in disguise in a huge travelling coach. All day long they travelled unmolested under a burning sun along the white roads. At Sainte Menehould, the postmaster Drouet's son wondered who they might be, and resolved to stop them before they crossed the French frontier. The coach had half an hour's start, but Drouet knew all the short cuts, and a man on horse-back could travel more quickly than a heavily laden coach

At Varennes Drouet raised the alarm, put a cart across the only bridge over the Aire and threatened to shoot if the party drove on. Then one of the crowd recognized Louis and his chance of freedom was over. The horses' heads were turned round, and the King was driven back to Paris.

This attempted flight was a shock to the monarchy from which it did not recover. The King for the future counted for nothing, though it was another year before they deposed him, and proclaimed a republic, and another few months before they guillotined him as a traitor to his country.

Louis' last words were, "Sirs, I am innocent of that of which I am accused! I hope my blood will consolidate the happiness of all Frenchmen." Never was Louis so kingly as at his death. About six months later Marie Antoinette followed him to the guillotine. On this followed the Terror, during which two thousand were guillotined. The revolution which had begun so favourably on 4th August and 26th August, ended in blood.

NAPOLEON BONAPARTE

The new ideas of the French revolutionaries—Liberty, Equality, and Fraternity—and the guillotining of Louis XVI and Marie Antoinette, and of thousands of French men and women suspected of not being whole-hearted in their support of the new French Republic led to war between France and the rest of western Europe. The hero who gave France glory in that war was Napoleon Bonaparte.

Napoleon was born in 1769 in the island of Corsica, off the coast of France and Italy. He was trained to be a soldier, and first made his name at the age of twenty-three by driving the English out of Toulon harbour (1792). Three years later he had his chance. The Directors (as those were called who governed France after the Terror) wanted a soldier to safeguard the meetings of the Convention Assembly. One of them said, "I have the man whom you want. He is a little Corsican officer who will not stand upon ceremony." The Director's confidence was justified, for Napoleon quelled a riot in the Paris streets by "a whiff of grape shot."

Next year he was given command of the army in Italy, where the French were fighting against the Sardinians and the Austrians. The French forces Napoleon found almost in despair. He put fresh heart into them, and defeated the Sardinians in three weeks, showing in the campaign the physical courage which gained him the affectionate title of "The little Corporal," and the generalship that made him a centre of attention though he was but a sallow, thin little man with lank hair, and a straight coat buttoned up to the neck. He followed up the Austrians and made them make a treaty very favourable to France.

Already his mind was looking for greater worlds to conquer. He next attacked Egypt, realizing that it was against the British he must strike. There he was equally successful on land, but the British fleet under Nelson defeated the French fleet at the Battle of the Nile and Napoleon, seeing that nothing more could come of his Egyptian campaign, slipped away from Egypt, and, eluding the vigilance of the English fleet, landed in the south of France

In his absence the French had been unsuccessful. They realized that the one man who could bring them victory was Bonaparte, so, giving him the title of First Consul, they entrusted France to his care.

Napoleon as First Consul quickly put an end to French defeats, and then set himself to organize the government at home. The revolutionaries had guillotined Louis XVI, but they had not been able to get the French to agree to another form of Government. Napoleon ordered his lawyers to draw up a code of law, the Code Napoleon, which is to this day the law of France. The revolutionaries had tried to abolish the Roman Catholic Church in France. Napoleon recognized Roman Catholicism as the religion of his country. In all matters which were discussed and settled it was Napoleon who by his clear brain and untiring energy took the lead.

After less than five years as First Consul, Bonaparte took the title of Emperor of the French, crowning himself in the Cathedral of Nôtre Dame in Paris.

Napoleon, at one time or another, had conquered all his foes in Europe, but the British he could not conquer. He realized that the only way to make the British yield was to invade England and defeat the British army. To do this he collected troops and had built flat-bottomed boats. Then he realized that unless he had war ships to escort them to England, the English might attack them in the Channel, and his whole scheme fail Napoleon, however, had no war ships that he could use for the purpose, since Nelson and Cornwallis were blockading the two chief French fleets of war ships in French harbours. One of these fleets managed to escape, but Nelson defeated it at Trafalgar. Napoleon could not invade England.

Instead, he attacked and defeated the Austrians, beat the Prussians at Jena, and made

By courtesy of *Victoria and Albert Museum*

FIG. 71
Napoleon

an alliance with the mighty Czar of Russia. The Austrians fought again, were again forced to make peace, and to give their princess, Marie Louise, as wife to Napoleon. Napoleon had long been married to Josephine Beauharnais, but he divorced her to marry a princess who, he hoped, would give him an heir.

Napoleon dreamed of a still greater Empire for himself, but the very greatness of his ambition raised enemies against him. Finally, Spain, Russia, Prussia, and Austria resolved to attack him at once, backed by the gold and armies of Britain. Napoleon's generals were foiled in Spain by the perseverance of Wellington, Napoleon himself was defeated in Russia, by the rigour of the weather and his failure to feed his army. He was defeated at Leipzig, and retreated to Paris, where he was forced to abdicate his position as Emperor.

For ten months he lived in exile on the little island of Elba off the coast of Italy, and then, hearing that his successor, Louis XVIII of France, was not popular, he crossed in secret to France and collected round him his old troops who by this time had forgotten everything except that he had led them to glory.

The allies, England, Prussia, and Austria, realized that they must defeat him once more. Napoleon made a speedy march into Belgium, hoping to fall on them while they were still scattered. He was, however, finally defeated at Waterloo, and then was sent to St. Helena, a little island in the South Atlantic where, six years later, he died. After twenty years his body was brought to Paris and buried at Les Invalides with the splendour that was then felt to be due to the greatest soldier and statesman that France ever produced.

ABRAHAM LINCOLN

George Washington, more than any other man, made the United States of America. Abraham Lincoln saved the United States when it looked as though the Union would split up on the question of slavery.

Abraham Lincoln was born in 1809 in a one-roomed hut in the backwoods of Kentucky. His father was a restless, easy-going man, who roamed about from place to place, but always far from civilization, so that Abe, as he was familiarly called, could get no regular schooling. Encouraged by his step-mother, he succeeded in educating himself He read a "Life of Washington," which made a great impression on him.

His first big venture into the world he took with a friend of his in a flat-bottomed boat down the Mississippi River as far as New Orleans. He had never seen a town before, and was amazed at the contrast it presented to the backwoods. A little later he went to New Orleans a second time, and on this occasion he saw the slave market in the city. Lincoln was very tender-hearted, and the picture of families of slaves being separated as husband, wife, and children were knocked down to the highest bidders shocked him, and remained in his mind as a lasting memory.

Next Lincoln became the manager of a general store, which quickly became the meeting place of the village, men and women coming to chat with each other, and to listen to the amusing tales of the store manager.

Lincoln then qualified as a lawyer. He was remarkable for his honesty, and for his efforts to persuade people to settle difficulties between themselves rather than in the law courts.

Meanwhile he was becoming more and more interested in politics, and in 1847 he was elected a member of Congress. Here he looked an odd figure in an assembly of well-dressed and smooth spoken men. He was six feet four in height, thin, and muscularly very strong. His hands were large and marked by the manual labour he had done. He never learnt the art of wearing his clothes comfortably, and always looked as though he had outgrown his coat and trousers. His rugged face under bushy black hair was plain, but his broad high forehead and grey, deep-set eyes plainly showed force of character. He was a powerful speaker, convincing his audience, not by tricks of oratory, but by his deep insight into the points at issue. His speech was plain, terse, and forcible, and he hammered home his points by humorous anecdotes which convulsed his audience.

Meanwhile the question of slavery was coming to the fore and separating north and south. Some men held that it was so evil an institution that it ought to be abolished immediately. Others held that slavery was perfectly natural and right. Lincoln held that it was an evil.

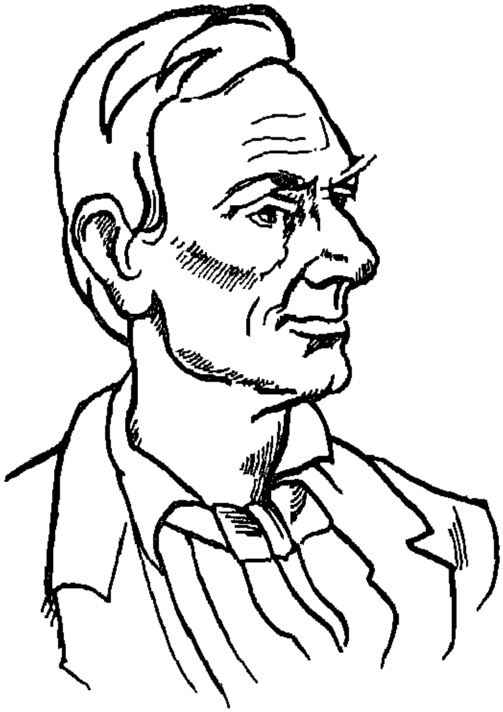


FIG. 72
Abraham Lincoln

"When the white man governs himself, that is self-government: but when he governs himself and also another man, that is more than self-government, that is despotism. There can be no moral right in the enslaving of one man by another. Little by little we have been giving up the old for the new faith. Nearly eighty years ago we began by declaring that all men were created equal [The Declaration of Independence], but now, from that beginning, we have run down to the other declaration that for some men to enslave others is a 'sacred right of self-government.' These principles cannot stand together. They are as opposite as God and Mammon." Lincoln, however, did not favour immediate abolition because that would mean depriving men of slaves they had paid for.

Just about this time Mrs. Harriet Beecher Stowe published a novel called *Uncle Tom's Cabin*, which brought many readers to sympathize with the slaves.

John Brown made a brave but futile effort to raise a slave rebellion. He was shot, but as the song says—

His soul goes marching on.

In 1861, Lincoln was chosen President. He did not want civil war, but the South forced it on him by attacking Fort Sumter. As President he could not allow this. The South was disobeying the government and breaking away from the North. The Union of the States was being dissolved. Lincoln and the North had no army ready, but there was no scarcity of untrained volunteers, who came singing lustily—

We are coming, Father Abraham,
Five hundred thousand strong.

During the terrible Civil War which lasted for four years, Lincoln needed all his qualities. Members of his Cabinet turned against him, his generals failed him, many misunderstood him. His patience was inexhaustible, his courage never failed. "Let us have faith," he said, "that right makes might and in that faith let us to the end dare to do our duty as we understand it" In the course of the war Lincoln issued a proclamation setting free every slave in the United States.

Toward the close of the war, when it was already apparent that the North would win, Lincoln was elected President a second time. He outlined his future policy thus—

With malice towards none; with charity for all, with firmness in the right, as God gives us to see the right, let us strive to finish the work we are in to bind up the nation's wounds to care for him who shall have borne the battle, and for his widow and his orphan; to do all that may achieve and cherish a just and lasting peace among ourselves and with all nations.

In the hour of triumph he was shot, but his work was accomplished—

By his genius he had guided the state through the terrible calamity of civil war; he had dealt with the slave problem wisely, and he had given the slaves freedom when the time was ripe; he had brought peace out of bitterness, unity out of strife; above all he had preserved the Union and made America, more securely than ever, a nation.

FRIDTJOF NANSEN

Nansen was born in 1861 near Christiana, the capital of Norway. In his youth he spent much time camping amid the trees and snow of his native land. He was a superb horseman, a wonderful hunter, and a fisherman of surpassing skill and cunning. Before he was seventeen, he won the Norwegian national distance skating championship. Next year he broke the world's speed skating record for a mile. Then he took to ski-ing and won the great national cross-country contest, which marked him out as being the leading athlete in Norway for that year. Twelve times he won this event, and then he retired, but he never ceased to be interested and take part in this sport

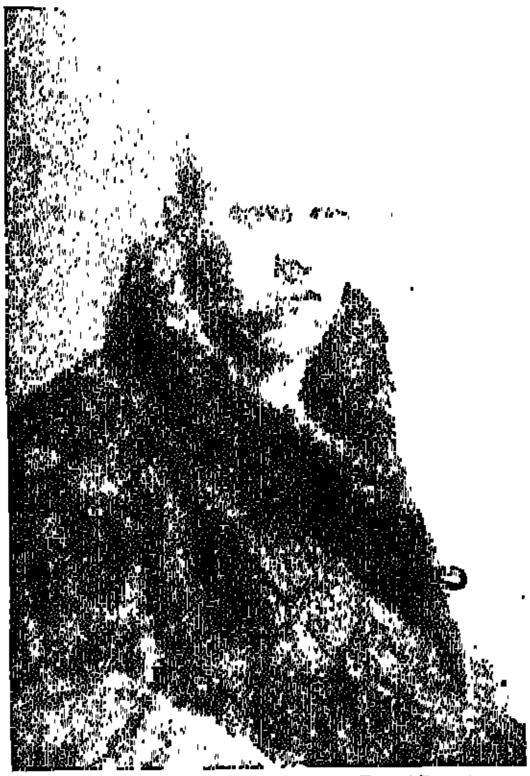
Meanwhile he attended the University of Christiana. Then at the age of twenty-seven he planned and carried out the first crossing ever made over the ice-cap of Greenland, when every one said that his scheme was madness

A year later he planned an expedition that he hoped would reach the North Pole and bring him the honour of being the first man to reach it. For this he designed a special ship which he called *The Fram*, which means "forward." The boat was of immense strength and of peculiar form, pointed at the bow and stern, and having sloping sides: if it should collide with ice flows, they would tend not to crush, but to slip beneath and lift her. He chose the wood for her and supervised her building

In 1893 he set out, sailed north until *The Fram* was frozen in, and then with one companion set out on his dash northward. Before he set out from home people told him that his scheme was utterly foolish, but he believed, contrary to other arctic explorers of the time, that the smaller the party the less the risk.

The two went in almost daily peril of their lives from bears, walruses, and icebergs, but Nansen was a dead shot and no danger could shake his nerves. They lived like the Eskimo, using the same kind of light sledge, and getting their food almost entirely from hunting. They reached a point farther north than any man had then reached, but they had to turn south without reaching the Pole because winter was coming on. They wintered, without knowing where they were, in Franz Josef Land One day Nansen heard a voice speaking in English. It was Jackson, who had come to look for him. After three years in the frozen north Nansen returned to civilization.

Meanwhile *The Fram*, which he had left in



Topical Press Agency

FIG. 73
Dr. Fridtjof Nansen

charge of one of the crew, was carried farther north by the field of ice in which it was wedged, farther north than any ship had ever been before In the third year it was carried south and arrived back in Norwegian waters a week after Nansen, to be used again by Amundsen in his successful dash for the South Pole.

Because Nansen was a great lover of his

country he next became interested in politics. At that time Norway and Sweden were united under one king, but the Norwegians did not like it, and wished to become an independent kingdom. Nansen wrote articles and spoke in favour of independence with the result that in 1905 the two countries separated without bad feeling remaining behind. This peaceful settlement was largely due to Nansen's tact and breadth of vision.

Next he was for two years Norwegian Minister in Britain. No man could have been found more likely to win the confidence of British people for the new state. Then he gladly returned to Norway to lecture.

Then in 1914 the First World War came, and Norway, like some other neutral countries, suffered. Nansen was chosen as the best man to send to the United States to make for Norway a Food and Shipping arrangement, so that Norwegian trade should not be altogether crippled.

It is what Nansen did for those who were suffering from the results of the Great War which will make his name memorable for ages to come, and which entitles him to be ranked with the heroes of all time. He was asked in March 1920, by the Council of the League of Nations, to arrange to get back home the prisoners of war. No one could tell him how many there were, and where the camps were in which they were stationed. It was left to him to find the ships and the trains required, to provide the stores of food and clothing that would be necessary. To do all this would require money, and the Council could offer him none. His courage did not fail before this huge task. Within a month he left Oslo and his native country to go to Moscow. He organized a fleet of ships in the Baltic and in the Black Sea. He and his helpers brought back half a million prisoners of war scattered throughout Europe and Asia, from the miserable camps in which they were herded together to the homes that they had lost all hope of every seeing again.

The next year he appealed to the League of Nations for a loan to fight the famine in Russia of which millions were dying, and he got it.

In 1920 there were one and a half million refugees scattered about Europe unable to claim that they belonged to any state, and most of them penniless. Under Nansen's organization food and lodgings were found for the destitute, and after great difficulty work was found for many of them.

In doing all this Nansen wanted to help those who were suffering, but he also wanted to persuade every one of the value of the League of Nations which could do work impossible to one nation alone. He believed that the more people trusted to the League of Nations the less danger there would be of war in the future. He it was who persuaded Norway to enter the League, and the action of Norway decided other wavering neutrals. Again, when in 1923 it seemed likely that War would break out because Italy had occupied Corfu, he used every ounce of his influence to back up the League in its entirely effective plans for peace.

Nansen realized that the League would have no strength until it included those who had been our enemies in the Great War. In the Assembly of 1924 he began the first informal conversations which finally led to Germany entering into the League.

Nansen died in 1930. He deserves to be remembered because he gave up his athletics, his exploration, his writing, and his lecturing to bring help to the suffering. He was the best of all advertisements for the League of Nations in that he showed people that it could and would do something practical which a single nation could not do.

This story will provide one of many opportunities for linking up history lessons with recent events. The Second World War is already not within the conscious memory of most Juniors, but older Juniors will and should know something of it, and the way should be prepared for an active interest in the United Nations Organization.

BRITISH HISTORY

CARADOC

ABOUT the time when Jesus Christ was a boy Caradoc was born. He was a British Prince, the son of Cunobelin, who ruled over one of the tribes in Britain, and whose capital was at Colchester in Essex.

Although Caradoc was a prince he did not live in a beautiful palace, for no one in Britain knew how to build palaces. He dwelt in a large wooden hut in the middle of which blazed a fire. At night all slept in the hut with their feet toward the fire. The attendants on the King made all that he required. They prepared his food and made his clothes, for in those days there were no shops in Britain from which to buy necessities.

Fig. 74

A Druid Preparing to Cut Down the Sacred Mistletoe

The custom of hanging up mistletoe in the home at Christmas is derived from these ancient religious rites

As he grew older Caradoc was taught by the Druids, as the priests of that time were called. They did not give him books out of which to learn, but they taught him many things by word of mouth.

The King's attendants taught Caradoc how to hunt and how to use a bow and arrow, a dagger, and a sword, and to ride in one of the war chariots. These chariots were made of wood, and were borne swiftly along by two horses. Attached to and jutting out from the axle were knives, so that an enemy made haste to get out of the way of a war chariot. (See Fig 76.)

As Caradoc grew older his father Cunobelin often spoke to him about the Romans, and particularly about the greatest of the Romans, Julius Caesar. Cunobelin told Caradoc that Julius Caesar had come to Britain about eighty years before from Gaul, as France was then called. Caesar defeated the Britons of the south who thronged the shore, not because the Romans were braver than the Britons but because they had better weapons and armour. After three weeks Caesar went back to Gaul. The next year

Fig. 75

A British Warrior

he returned, and this time he crossed the Thames and captured the town of St. Albans, which was not very far from Cunobelin's royal town of Colchester, but he shortly afterwards returned to Gaul and never troubled the Britons more. Cunobelin added that he hoped that the Romans would never come again.

However, in A.D. 43 news came that the Romans were coming to attack Britain, and the Britons in this time of crisis looked to Caradoc, who had become King on the death of his father, to lead them against the dread foe.

The Romans landed in the south of Britain, probably not far from Sandwich, and met the troops of Caractacus (the name by which the

Romans called Caradoc) on the river Medway. The Britons thought that, as the river was between them and the Romans, they would be quite safe from attack, but some of the Roman soldiers managed to swim across the stream. The next day there was a great fight.

Caradoc encouraged his men to fight bravely. He wore a horned helmet made of bronze and a beautiful bronze shield, and he was armed with a good sword and dagger, but most of the Britons had neither breastplate nor helmet, and relied upon bows and arrows. (See Figs. 45 and 76.)

Each of the Roman soldiers wore a breastplate covering the upper part of the body, greaves on the legs, and a helmet, and each carried on the left arm a large strong shield. The Romans were armed with short swords and light daggers, and with long javelins to throw. They looked very well-trained soldiers, and as their general addressed them they stood to

FIG. 76

Workmanship of the Britons. Weapons and Transport

attention. At their head was a standard bearer, carrying the Roman Eagle, which was as dear

FIG. 77
A Roman Standard Bearer

to the Roman soldiers as the Union Jack is to the British "Tommies" to-day.

The Britons fought fiercely, but the Romans fought steadily. The Romans stood still until the general gave the word to advance. Then, in a solid mass, each man keeping step with the man next him, they came on to the attack. At the command "Hurl javelins" they threw their javelins and killed many of the British. Never before had Caradoc seen soldiers who were so controlled, and in spite of his bravery and the fierceness of the Britons they had to flee.

Again the Romans came up with the Britons and another battle was fought, and again the Britons fled. As the Romans followed them up they became entangled in the marshes of Essex, and the Britons turned on them and killed many.

Then the Roman Emperor, Claudius, the

FIG. 78
Ancient British Pottery

greatest king in the world at that time, came over to Britain, and he and the Romans captured Caradoc's fortress at Colchester. Once again Caradoc escaped, and, taking some of his men with him, he went to find safety in South Wales.

For seven years Caradoc could do little, but at the end of this time the Romans, having conquered most of the plain of England, resolved to fight Caradoc, who was a perpetual source of danger to them. The last battle was fought at a place which is still called Caer (Camp) Caradoc.

Caradoc posted his men on a steep hill and defended all possible approaches by mounds of loose stones. Between this hill and the Roman camp was a river. Caradoc then addressed his men. "This day must decide the fate of Britain. The era of liberty or of eternal bondage begins from this hour. Remember your brave ancestors who drove the great Caesar himself from these

shores and preserved their freedom, their property, and the persons and honour of their wives and children."

The Romans managed to ford the river. Caradoc's men let fly a shower of darts, but the Romans, keeping close together and holding their shields over their heads, advanced. The darts of the Britons rained down on the shields, which were like the scales on a tortoise's back, but did no damage (see Fig. 54). Thus in safety the Romans climbed the hill, tore down the barricade of stones, and put the Britons to flight. The Romans captured the wife, daughter, and brothers of Caradoc, but he managed to escape to the mountains. There he would have been safe had not his stepmother, who was a queen of northern Britain, treacherously handed him over to the Romans.

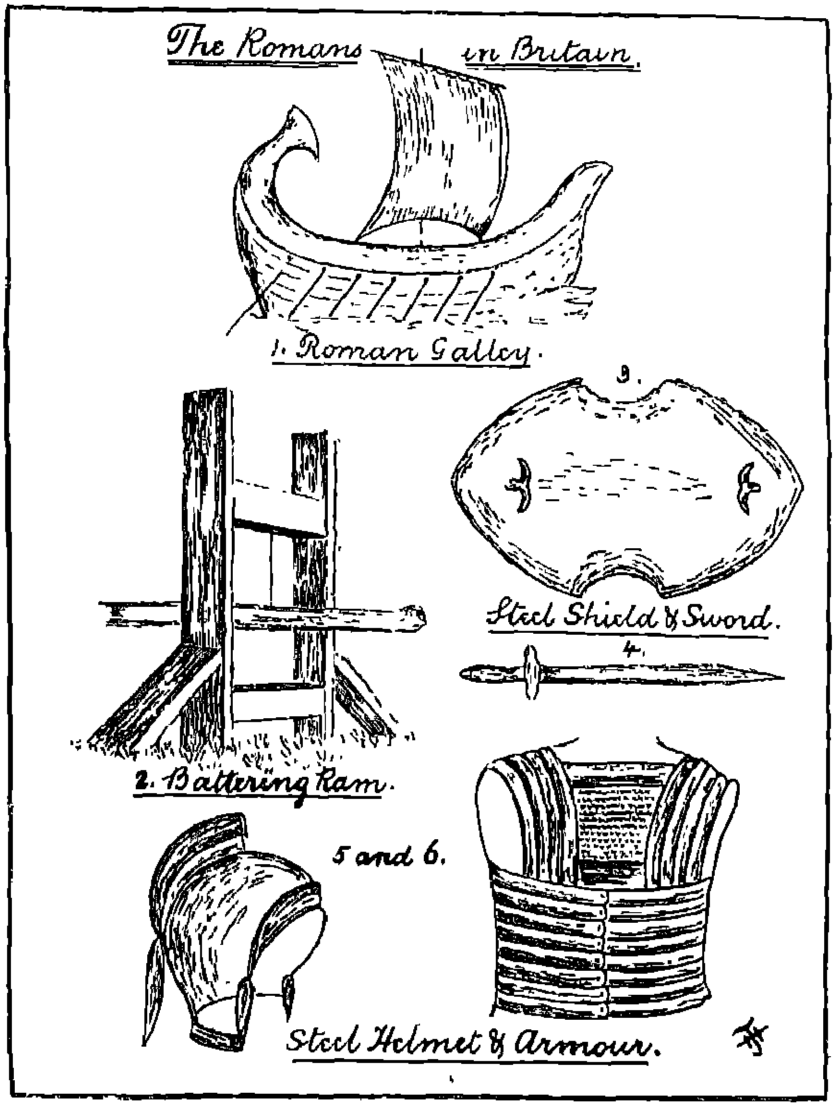


FIG. 79

Caradoc and his family were taken in chains to Rome. They had to travel on foot, using the good roads that the Romans had made. At length they came to Rome itself, the capital of the Empire.

Now when a Roman general had won a great victory he was given a Triumph. In that Triumph Caradoc and his family were led in chains along the Sacred Way to the Temple of Jupiter on the Capitoline Hill. As Caradoc passed through the streets he marvelled at the wonderful buildings of Rome, and remarked that he wondered that the Romans, who possessed such palaces, should envy the poor huts of his people, the Britons.

Caradoc and his family were taken to the palace of the Emperor Claudius. The rest begged for mercy but Caradoc said, "You fight to gain the whole world and to make everybody your slaves. I fought to keep my own land and for freedom." He added that the resistance he had made was a large element in his conqueror's glory; that if he were now put to death he would shortly be forgotten, but that if spared he would be an imperishable monument to the imperial clemency.

Claudius, much moved by Caradoc's fearless bearing and words, ordered that Caradoc's chains should be struck off, and that he should be allowed to go free.

HOW ENGLAND GOT ITS NAME

When Caradoc was King our country was called *Britain*, and its inhabitants were *Britons*. At that time the English did not live in England but in northern Germany. This is the story of how the English, or Angles, left Germany, came to Britain, and introduced the name *England* (Angleland).

FIG. 80
An Anglo-Saxon Priest

On the shores of northern Germany there lived three peoples, the Angles, the Saxons, and the Jutes, who were very like each other. They were tall, fierce men with golden hair and blue eyes, and their chief pleasure in life was fighting. They did not have one king to rule over them but each tribe had its own chieftain.

When the chiefs went into battle they put on shining armour made of links of steel and costly helmets inlaid with gold. They fought with swords and grey-tipped spears of ash, and carried a shield of linden wood covered with leather and strengthened in the centre with a boss of iron. With the chief went his followers, young men who had chosen to serve him because of his well-known bravery. They would have thought it shame not to have stood by him to the death in a fight.

These men had never heard of Jesus Christ. They worshipped gods who were fierce like themselves. The father of the gods they called Woden. He dwelt in Valhalla, their name for heaven, and welcomed there brave warriors who were killed in war. Even now we call Wednesday (Woden's day) after him. Thor, their god of Thunder, has given his name to Thursday.

FIG. 81
A Saxon Warrior

When a battle was over the chiefs and their followers loved to feast on much meat and to drink mead, while they listened to the minstrels singing of the great deeds of the men of old (see Vol. I, p. 151).

Northern Germany, where they lived, was very poor in soil and they could not grow good crops, so many of these warriors went to sea to plunder other lands. Their little boats were about 75 ft. long and 10½ ft. wide. Each boat could carry thirty to fifty men, who were all busy rowing it. (See Fig. 85, p. 668.) They were very small boats in which to cross the stormy North Sea, but the Angles, Saxons, and Jutes enjoyed going to sea, as their songs show.

These men had plundered the shores of Britain even when the Romans were there, and when they found out that the Romans had left they knew they would have an easy task to row up the rivers on the eastern side of Britain till they came to a town, terrify the Britons into giving them any gold and silver ornaments and

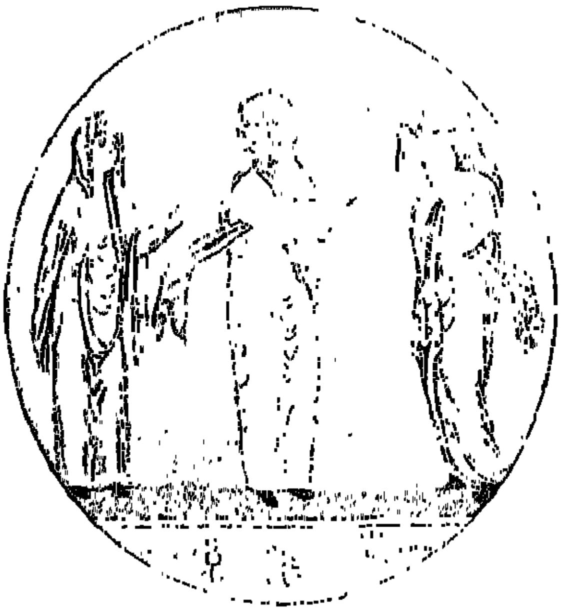


FIG. 82

Eighth Century Costumes

These are the kinds of dresses which the Anglo-Saxon ladies made for themselves in the eighth century.

anything else of value that they had, and then row away before the Britons could punish them.

After the Romans left Britain in A.D. 410 the Britons were attacked by fierce tribes of Picts from Scotland, and by Scots from Ireland. Though the Britons fought bravely they could not keep them out. So Vortigern, a King in south-east Britain, invited two of the Jutish chiefs, Hengist and Horsa, to help him against the Picts and Scots. The two leaders landed at Ebbsfleet in Thanet in Kent, and drove back the Picts and Scots. Vortigern was soon sorry that he had asked their help, for, when Hengist and Horsa saw that Britain was a more fertile land than their own, they made up their minds to take it from the Britons and settle down in it themselves. They sent messages to their friends in northern Germany to come and settle too. The Britons tried to drive them away, but they could not, for boat load after boat load of these fierce warriors came over, and the unwarlike

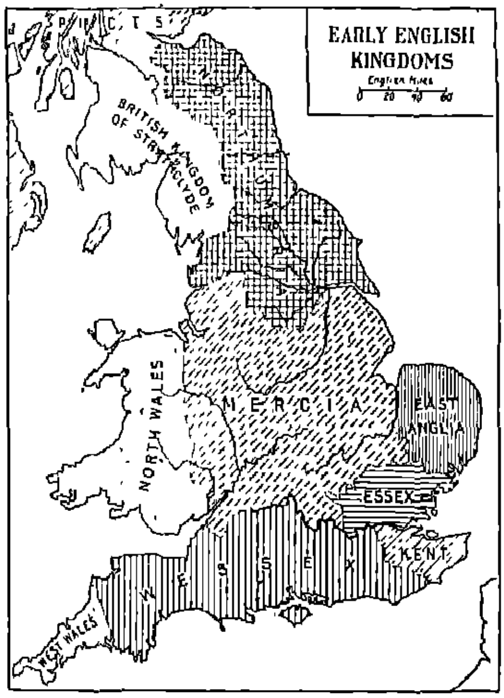


FIG. 83

Map of the Early English Kingdoms

Britons were no match for soldiers who had spent their time in doing nothing else but fight.

For a hundred and fifty years the Angles, Saxons, and Jutes were fighting against the Britons. In the end the Britons were driven into the mountainous parts of Westmorland and Cumberland, and into Wales and Cornwall, and some left Britain and went to live on the western coast of France called Brittany. The people who live in these parts to-day are the descendants of the Britons. The Angles, or English, settled in Britain and called it Angle-land or England.

The Angles settled in Norfolk and Suffolk, which we still call East Anglia, and in Northumbria. The Saxons dwelt in Essex (East Saxons), Sussex (South Saxons), Middlesex (Middle Saxons), and Wessex (West Saxons). The Jutes made their homes in Kent and in the Isle of Wight.

The newcomers did not choose to live in the towns that the Romans had built. Oftentimes they burnt the Roman towns when they captured them from the Britons. They had not lived in towns in Germany, and in England they lived in the open country, each family settling down and making a little village. They called each little village a "ton" or a "ham," meaning a town or a home. Where in England to-day a town or village has a name ending with "ton" or "ham," as Wallington or Birmingham, we may guess that an English family settled there.

Though the English had been sea-rovers and fighters, after they had conquered England they became farmers. Outside each village there were three big fields. In one of these the villagers sowed wheat for bread, in another barley for beer, and the third they left fallow, so that it could have a rest from growing crops. Every year one field was left empty, and each field had a rest once in three years. Each of the men of the village had more than one strip of land in each field, some good land and some poor land. Each strip was marked off from the next by a narrow path of grass.

In the winter the villagers went to plough with their wooden ploughs drawn by oxen. In the spring they scattered their seeds by hand. In July they cut the hay with scythes, in August they harvested the corn, and in the winter they threshed it with long flails.

Near the stream which flowed through the village there was a big meadow, in which all the cows and oxen grazed in charge of a cowherd. Farther away from the village was some poor land, called the common, where a shepherd tended the sheep and a swineherd looked after the pigs while they ate the acorns from the oak trees and the beech mast. All the animals were marked so that their owners could recognize them.

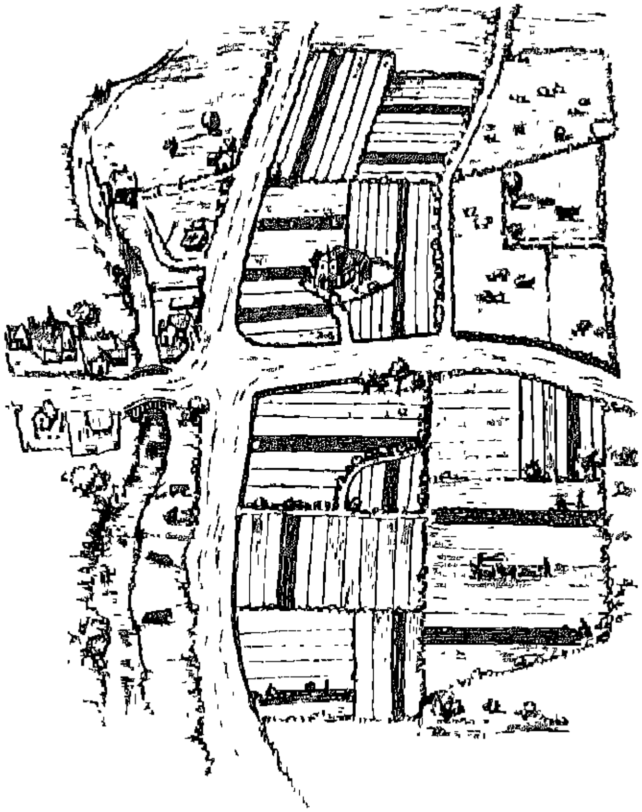


FIG. 84

An Old English Village

One of the three large fields lies fallow and cattle are grazing in it. In the other two fields the strips held by one villager are shaded dark; note how scattered they are. A plough team is at work in one of the fields. Between the road and the stream is a meadow with cattle. Higher up the stream, beyond the bridge, is the mill.

The villagers lived on the corn, milk, meat, and beer. They used the leather from the cattle and pigs, and the women made up the wool sheared from the sheep into woollen cloth, and then made loose flowing robes for themselves, and shirts, breeches, and tunics for the men.

Activity

Set up the model of an Anglo-Saxon village in the sand tray. In setting out the three fields leave the fallow field smooth, score the one under the plough with a stick, and put bits of grass over the third one to represent the growing crop. Beyond the three fields represent the forest by bits of twig stuck up in clay. In the forest leave bits of twig to represent the logs ready to be brought home by the villagers. Put into it either pigs and sheep from a Noah's ark, or let the children model them in clay. Cover the meadow land with moss to represent grass, and put cattle into the meadows. Let the children make in paper or clay the little huts of the villagers.

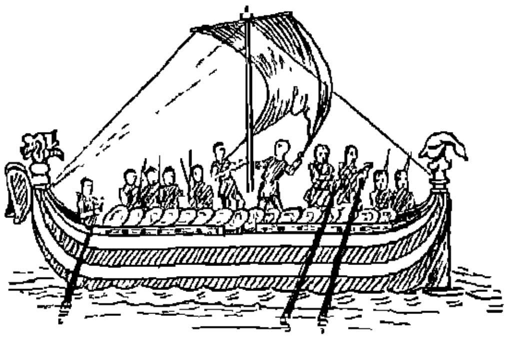


FIG. 85
A Saxon Ship

FIG. 86
Two-handed Wheel Plough

FIG. 87
Reaping and Carting Corn

These two illustrations are taken from an English calendar which was made in the eleventh century just before the coming of the Normans. The January scene represents ploughing with a two-handed plough. Notice the man who is goading the oxen. The August scene represents the corn harvest. Note that the reapers are cutting with their sickles close to the ears of corn, leaving much straw standing.

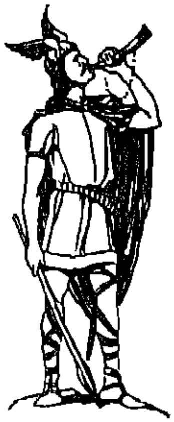


FIG. 88
A Danish Raider

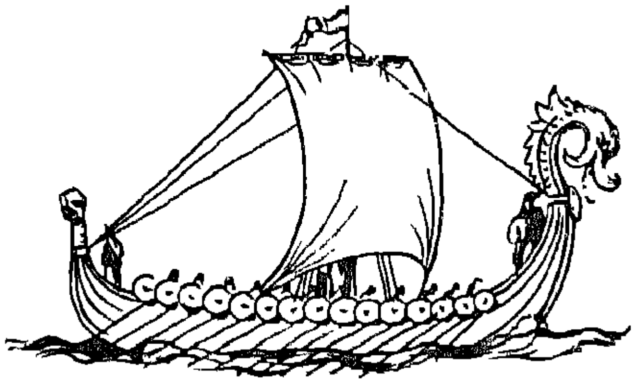


FIG. 89
A Danish Ship

FIG. 90
A Dane who had settled in England

FIG. 91
King Alfred the Saxon

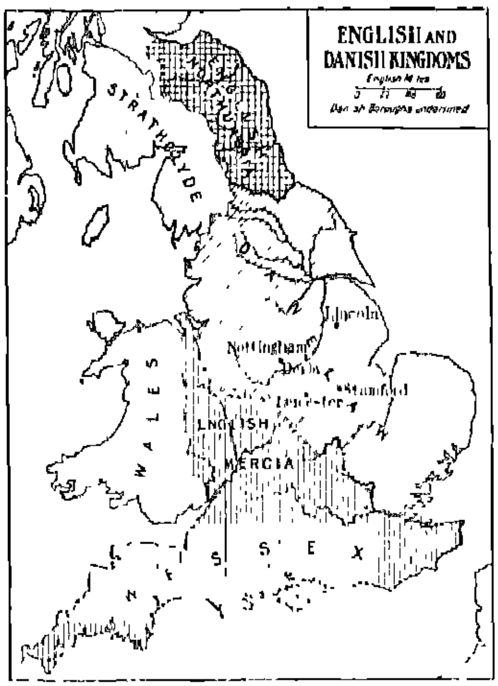


FIG. 92
English and Danish Kingdoms

FIG. 93
William I from his Seal

THE BAYEUX TAPESTRY

Introduction

There is a gap of six centuries between the coming of the English and the coming of the Normans. The syllabus should allow for lessons on the conversion to Christianity of the English, Alfred the Great, and the Danish attacks on England, and on Canute, the Danish King of England.

After six centuries of struggle we come to the time when the Saxon Edward the Confessor was king.

The Norman Conquest

In the Church of the old Norman town of Bayeux there used to hang a piece of embroidery worked on linen in eight differently coloured worsteds. It was 200 ft. long, and thus was long enough to hang all round the nave of the church. It was placed above the arches, and as it was 20 in. wide it made a strip of decoration between the nave arcade and the clerestory above. Nowadays it hangs not in the church but in the Museum in the town.

The embroidery has sixty different pictures on it, one picture coming after another. It is believed that Odo, Bishop of Bayeux, the half-brother of William the Conqueror, suggested that it should be made, and that Queen Matilda, the wife of William the Conqueror, and the ladies of her court embroidered it. It gives the most graphic account we have of the Norman Conquest of England.

The first picture shows King Edward the Confessor seated on his throne. No doubt he and Harold, his most important subject, were speaking about the journey which Harold was about to take.

Harold and his followers rode to the coast, entered a church to ask God's blessing on their enterprise, and put to sea. Each boat had but one sail. Since the wind was favourable they quickly came to the shores of France. Here Guy of Ponthieu, accompanied by a troop of horsemen, arrested Harold and his companions. William, when he heard of Guy's capture, ordered that Harold should be handed over to him. Duke William of Normandy went out to meet Harold and took him to his fine castle at Rouen.

At this time William was at war with the Earl of Brittany, and he invited Harold to accompany him on a military expedition. When William and Harold had succeeded in capturing the fortified town of Dinan the Earl of Brittany came out of the captured town and delivered up the keys of the city on a lance to William, who received them in like fashion. William, to do honour to Harold for his valour in the war, knighted him.

Harold then wished to return to England, but William would not permit this until Harold had taken an oath to support William's claim to the English throne after the death of the childless Edward the Confessor. Harold was most unwilling to take the oath, but, realizing that this was his only chance of leaving Normandy, he consented. Harold took the oath over an altar beneath which were the bones of many saints, so that the oath was considered in those days as being particularly binding. Harold then returned to England.

Shortly after his return Edward the Confessor died without children and the Witan, as the assembly of wise men in England was called, offered the throne to Harold.

Harold was not of the blood royal of England, but for a long time he had been the chief adviser of the King, and his father Godwin had been the most important earl in the Kingdom. Harold, in spite of his oath, accepted the throne and was crowned.

News was at once sent to William that Harold had been crowned King. William, on hearing this, was very indignant, and resolved to invade England to win the crown for himself.

He ordered that a fleet should be built. When all was ready he commanded that arms should be taken aboard, and that the horses and men should embark. The next day the fleet came to Pevensey and William's troops landed. The sailors and squires disembarked first and unloaded the ships, then the archers disembarked, and finally the knights, who were fully armed. They seized the cattle of the neighbourhood for food, and after they had feasted William

"He came to King Edward" The King reprimands Harold for the failure of his mission to France
Note the workman placing the weathercock on to the building

"The body of Edward the King is carried to the Church of St Peter the Apostle"
Note the simplicity of the funeral Edward the Confessor built the first Westminster Abbey His shrine is still to be seen within the present Abbey

FIG 94

Scenes from the Bayeux Tapestry Depicting Life in England before the Norman Conquest

gave orders that a camp should be dug at Hastings.

News of William's landing was brought to Harold, who marched with all speed from Yorkshire, whither he had gone to defeat Harold Hardrada, King of Norway, and his own brother Tostig.

Harold's and William's armies met at Hastings. Harold made the English take up a good position on the hill, and ordered his men to stand close together with their shields in front, so that they presented a shield wall to the enemy. The Normans attacked them both in front and in the flank, but at first the English held their ground well, though some were forced to flee, and only with difficulty won their way back to the top of the hill.

At one period in the fight a rumour spread among the Normans that Duke William was killed. William rushed among his troops and encouraged them, and to assure them that the rumour was false raised his helmet so that all should recognize him.

At length Harold was slain. He was wounded by an arrow in his eye and beaten to the ground. The English fought on, but when the news spread that Harold was dead and that there was no longer any hope of victory the English fled,

FIG. 95

Norman Ship

This is a picture from the Bayeux Tapestry of one of the ships that William ordered to be built to carry his soldiers to England. Note that it has a single sail and is steered by a loose rudder in shape something like an oar. The boat is used for the transport of horses as well as of men

The victory at Hastings enabled William to become King of England.

Illustration and Handwork

This lesson of the Bayeux Tapestry is designed to give a certain measure of freshness to a story which is usually well known to the class.

At the Victoria and Albert Museum is a facsimile of the Bayeux Tapesty, and at the

Reading Museum a copy which is reduced in size. Teachers will find the Penguin book, *The Bayeux Tapestry*, by Sir Eric Maclagen, useful. Also it is possible to obtain from the Victoria and Albert Museum, South Kensington, London, S.W.7, a set of twenty-three post cards of the Bayeux Tapestry. When ordering quote the Numbers T46 to T53. Alternatively the lesson may be illustrated by two pictures from a series published by Marshall (46 Farringdon Street, E.C.4). The series, which is a good one because historically accurate, includes—

1. William crossing the Channel (Bayeux Tapestry).
2. The Death of Harold (Bayeux Tapestry).
3. Old English Byrnie and Shield.
4. Drinking Horn and King Alfred's Jewel.
5. Viking Ship.
6. Harvesting (from an eleventh century calendar. See Figs. 86 and 87.)

The story of the Bayeux Tapestry lends itself to acting. Handwork may take the form of representing in clay the Norman vessels. The armour and weapons of the Anglo-Saxons and Normans can be made. The Saxon byrnie or coat of mail can be made of string knitted and silvered over; the helmet and shield of cardboard, the steel parts represented by silver paint. Norman weapons and armour can be represented in the same way.

FIG. 96

Scene from the Bayeux Tapestry Depicting the Normans Shortly after their First Landing in England

"Here they have prepared the food and here the Bishop is blessing the meat and drink." The Bishop is Odo of Bayeux, William's half-brother. Note the chickens served on spits

FEUDALISM IN ENGLAND

Explanation

When William the Conqueror had defeated the English at the Battle of Hastings he took from them the land that they had had, and said that it was all his. He thus had far more land than he could use, but he was in need of soldiers and money. He, therefore, exchanged his surplus land for an army and money.

He called to him the Norman and other

barons who had helped to win the Battle of Hastings, and gave them some of his land in return for a promise that they would obey him, fight for him, and bring other soldiers when summoned, and pay him sums of money on special occasions.

These greater barons had more land than they could use, and they had promised to find soldiers and money for the King. They, therefore, gave some of their land to less important barons than themselves in return for a promise to fight when called upon, and give money on special occasions.

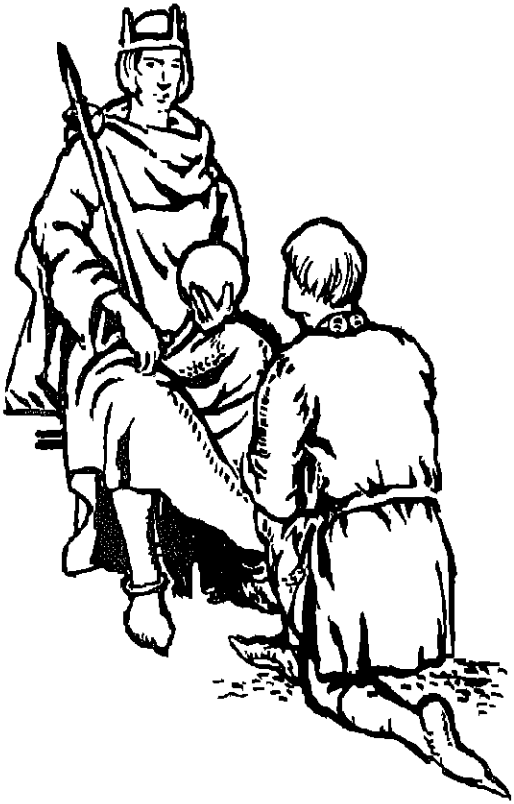


FIG. 97
Baron Taking Oath of Homage

The King gave some of his land to Bishops and Abbots. As they were not supposed to fight they promised to pray for the King, pay him money, and provide him with soldiers.

Action

After this explanation let the teacher seat herself on a high chair, announce that she is now William the Conqueror, and ask for volunteers to act as barons. Teach the volunteers a simplified form of the oath of homage: "I promise to become your man."

Let one child then come forward, kneel down in front of William, and put his hands together as though he were about to pray. William then holds the baron's hands between his own. Then the baron takes the oath. "I promise to become your man." Next William raises him from his knees and gives him a charter (made of a piece of paper rolled and tied up with red tape), and pins on him a label bearing his new name: "The Earl de Warenne."

Next the teacher chooses another child and explains that he is to act the part of Odo, Bishop of Bayeux, William's half-brother, at whose request the Bayeux Tapestry was made. Let the child explain that he will have to pray instead of fighting for the King. Repeat the act of homage, giving its name this time, and explaining that *homage* comes from the Latin word for "man"—"I promise to become your *man*."

Then let two children take the oath of allegiance to the Earl de Warenne and two to Odo, Bishop of Bayeux. Repetition proves useful.

By this time six children have parts to act and wear labels proudly. Arrange them with outstretched arms as in Fig. 98 for the class to see.

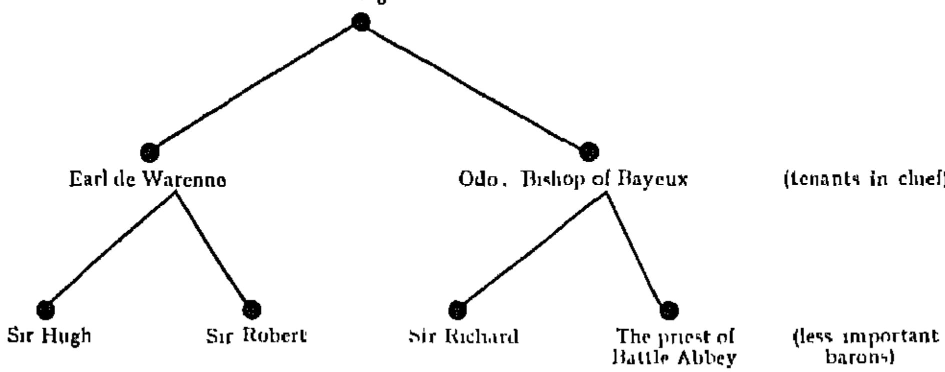
The children will gain the idea that there were comparatively few who held their land direct of the King and that, speaking generally, they had many acres, whereas there were many who held from the King's tenants-in-chief, but each of these had less land.

Add at this stage that William insisted that, though each man must obey his overlord, as he had promised, every baron's first duty was to obey the King.

Finally, put the diagram in Fig. 98 on the board. Explain that it represents the children who are acting as feudal barons, and then let all copy it into their notebooks as a reminder of the Feudal System.

The Knighting of a Squire

In the same way at the conclusion of a lesson on the training of a medieval boy of the knightly class the children may act the ceremony of the dubbing of a knight. A knight comes forward to put on the squire's spurs. A second sets on his armour, and a third girds on him his sword. Thus armed, the squire kneels before the great baron. The baron smites him on the right shoulder with his sword and says "Rise, Sir Hugh."



(● represents head and / represents an arm)

FIG. 98

Diagram Illustrating Feudal System

A VISIT TO A BENEDICTINE MONASTERY IN THE NORMAN PERIOD

It was evening time, and we had been travelling all day and were tired. We hoped that we had almost reached the monastery where we intended to stay the night, since in the time of the Normans there were no hotels.

FIG. 99

A Benedictine Monk

At length we saw it in the distance, a group of buildings surrounded at some distance by a high wall.

We found the entrance door in the wall and knocked. The porter, who was one of the monks, or brothers, opened the door to us He was an old man with his hair shaved on the top of his head. He was wearing a long gown of coarse black woollen material tied round at the waist with a knotted rope. On his feet he wore sandals.

He took us to the guest house where we were hospitably received by the Guest Master, another of the monks, whose special duty it was to welcome guests and see to their comfort. Quickly a meal was placed in front of us, and after it was over the Guest Master led us to our bedrooms. In each was a low bedstead spread with blankets.

At midnight we were wakened by the tolling of a bell, and, seeing a light in the church, we made our way there The brothers were all present in their black robes busily chanting their midnight office (as they call their services). They sat facing each other, and those sitting on one side sang one verse of the psalm and those on the other the next, and so on till the psalm was finished. At the close of the service the monks went back to their dormitory to bed.

At six o'clock the bell rang again. The

brothers rose, washed themselves, and went down to church once more. After that they trooped into the Refectory, where breakfast was served on the plain wooden tables. The Father Abbot, the ruler of the monastery, and the other officials sat at the high table at one end. All kept silence during the meal, asking by signs for anything they required. Meanwhile one of the brothers read to them from some holy book.

After breakfast the monks went to the Chapter House for consultation. They sat on stone seats against the wall and the Abbot sat on a raised chair. If the Abbot wanted to let part of the lands of the monastery to some knight he brought forward the matter for the consideration of the monks. If any one wished to make a complaint against another brother this was his opportunity.

After the meeting in the Chapter House the monks returned to church for another service, and then each one went about his own business. The Infirmarer went to the sick room where the monks who were ill were in his charge. The Cellarer went to the brewhouse and the bakery to see that everything necessary for the food and drink of the monks for the months to come was being prepared and stored. The Kitchener went to arrange for the meals of the day, and not infrequently to provide hospitality for distinguished guests and their retinues. The Percentor spent his morning drilling the choir boys or tuning the organ, repairing or copying some music, or arranging for some ceremonial occasion in the church.

Let us pass into the cloisters. These were covered walks all round the square courtyard, which had a lawn in the middle. In one cloister the schoolmaster was teaching little boys whose parents thought that they might become monks when they grew up; they were learning a little Latin, so that they could follow the services in church.

In the cloister where the light was best monks were busy copying manuscripts. They used pens made of goose quills, and they wrote on parchment, which was sheepskin. The seat with the best light of all was left for the brother who was most skilful at illuminating. The brothers who copied the manuscripts did not fill in the capital letters but left them for the illuminator to do. He designed beautiful capitals and coloured

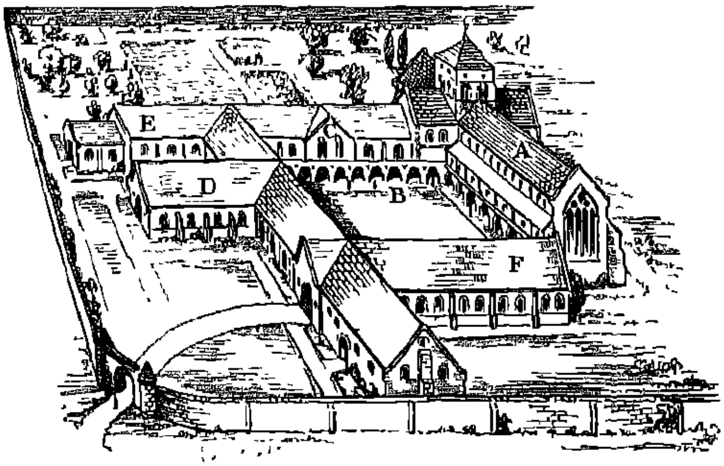


FIG. 100

Plan of Monastery

A = The Abbey Church
B = The Cloisters
C = Chapter House
D = Dining Room or Refectory
E = Dormitory
F = Quarters for Lay Brothers

them in vermilion, or bright blue, or green. Sometimes he decorated the capitals with little pictures, scenes from everyday life, or pictures of the saints.

In the third cloister were the novices, as those were called who were learning to be monks. Some were getting the Psalms by heart, while others were being instructed in how to pray and meditate by the Novice Master.

At midday the monks washed their hands and went into church to say another office. From there they went to dinner in the Refectory, a silent meal like breakfast.

After dinner some of the older monks retired to the dormitory for a rest. The younger ones continued the occupation of the morning. We, however, went to see what was done outside the cloisters, but yet within the precincts of the

monastery. Everything that was eaten or drunk or worn, almost everything that was used in the monastery, was made on the spot. Monks or lay brothers or paid men tilled the soil and grew the wheat. The clothes were made out of the wool from their own sheep. Tailors, shoemakers, carpenters, and blacksmiths lived close to the monastery to attend to its needs. In fact, if a monastery was planted in a lonely spot a little town soon grew up nearby to supply the wants of the community.

About six o'clock the monks had supper, following upon another service in church After that they had a time for recreation. This was an opportunity for the monk who kept the Chronicle of the Abbey to approach strangers who were staying there, and find out what had been happening in the world outside the monastery wall. If he gleaned news of note he jotted it down on a piece of parchment which he put for safety into the Chronicle. At the end of the year the Chronicler looked through all the loose sheets of parchment and entered in the Chronicle those events which seemed to him to

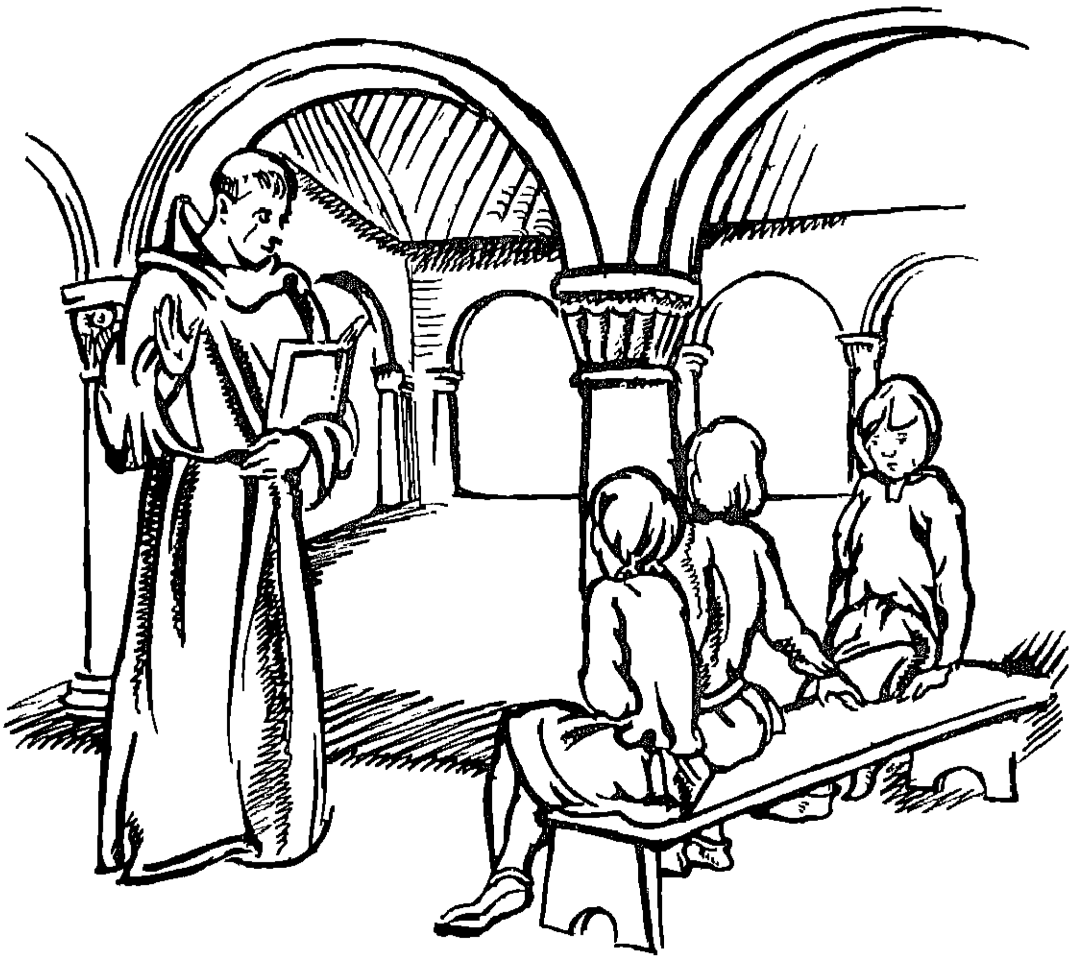


FIG. 101
Monk Teaching Children in the Monastery

be of note. It is from the chronicles kept in the monasteries that we learn much about the events of the Middle Ages.

After Vespers, the monastery gates were closed, and after the last service of the day the monks retired early to their dormitory. Finally the Prior, the official next in command under the Abbot, went round to see that all the monks were in their places, and then the day ended.

The next day began at midnight, when at the ringing of the bell the monks left their dormitory and silently descended by a small winding stair into the church below.

Memorizing and Re-telling

A useful device for recapitulating this lesson is to make beforehand labels bearing the names of the various officials of the monastery, and to give each of the labels to one of the class as the official is first mentioned in the story, telling the class that each of the officials will be responsible for explaining to the class at the conclusion what his duty was in the monastery.

By courtesy of *La Bibliothèque Nationale, Paris*

FIG. 102

A Novice Master Training the Novices

HENRY II (1133–1198)

Henry II, the great-grandson of William the Conqueror, was one of the ablest Kings who ever sat on the English throne. His mother, Matilda, was a proud, ambitious woman, "with the nature of a man in the frame of a woman." His father, eleven years Matilda's junior, was

FIG. 103
Matilda of Scotland, Grandmother of Henry II

Geoffrey the Handsome of Anjou, called Plantagenet for his love of the bright yellow broom characteristic of the Angevin countryside.

At eighteen Henry became Duke of Normandy in right of his mother, and his father's death made him Count of Anjou, Touraine, and Maine, so at the age of nineteen he ruled over a large block of territory in northern France.

The young count then visited the Court of the King of France at Paris, to do homage for Normandy and Anjou, and there for the first time he saw the French Queen, Eleanor of Aquitaine. Eleanor despised her husband for his ineffectiveness and superstition, and was attracted to the square-shouldered, ruddy youth, with his vivacious talk and overwhelming energy and scant ceremoniousness at church services. She procured a divorce from her husband, and two months later married Henry, taking to her new husband the vast lands in southern France of which she was the heiress. Henry was thus ruler of lands which in extent and wealth were double those of his suzerain

At twenty he set out to add England to his dominions. He had a good claim, for his grandfather, Henry I, whose only son had perished in the wreck of the White Ship, had made the nobles do homage to the baby Henry as heir. On the death of Henry I, however, when the young Henry was but three years old, Matilda and Geoffrey had been unable to make good his claim, and Stephen, Matilda's cousin, became King of England. At intervals Matilda had made valiant efforts for her son, with resultant civil war in England, but without success. Now Henry was old enough and powerful enough to claim his inheritance for himself.

After Henry had won two victories, Stephen saw that he must make terms, and so it was arranged in 1153 that Henry should be the adopted son of Stephen, a sharer in his kingdom while he lived, his heir when he should die. Henry had not to wait long. In 1154 Stephen died, and Henry was crowned at Winchester as King of England.

Thus at the age of twenty-one Henry was ruler of a vast Empire, to which part of Ireland was later added by conquest.

The chroniclers have left us full accounts of Henry's person and contradictory character. He had a short bull-like neck and a wide chest. He was bow-legged, and had very strong arms. His head was round and his hair, which was red, was kept very short. His face was fiery. His eyes were grey and protruding and sometimes bloodshot. He was careless of his appearance, and wore gloves only when he was hawking.

Henry had many useful kingly accomplishments. He had the royal memory for names and faces. He could speak well, and could be charming on occasions. He was fond of study, and attracted many men of learning to his court. "As often as he can get breathing time he

occupies himself with reading, and takes pains in working out some knotty problem."

The worst point of Henry's many-sided character was his violent temper. His face when he was angry would change; he would roll on the ground in a paroxysm of madness and vent his terrible wrath on the bystanders, while they whispered that this was all due to the supposed demon ancestress of the Angevins.

Henry's predominant characteristic was his boundless energy, every ounce of which he needed

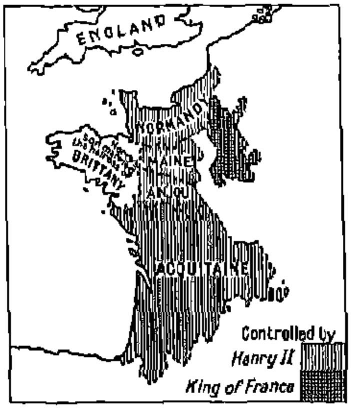


FIG. 104
France in the Twelfth Century

to rule his vast dominions. England alone proved a very difficult heritage. From the time when Henry I died (1135) till Henry II's accession (1154) the barons had done what they liked without check, and had backed up now Stephen and now Matilda in the civil war, so that the people significantly talked of this period as "the nineteen long winters," and said that their sufferings proved that "God and the Saints slept." Henry put an end to this, and gave England the blessing of firm and fair government.

Henry's first business was to check the power of the barons and assert his own. He bade them demolish the castles they had built under cover of the civil war, and punished severely those who delayed.

Then there was a vast mass of arrears of law suits, which had arisen as far back as the time of Henry I, and had gone unsettled through Stephen's reign. Henry set himself to work off the arrears and to see that all, from the highest to the lowest, should be subject to the royal law. He himself decided knotty points of law with business-like impartiality. He carefully examined every charter that was brought to him, and if it was imperfect he was ready to draw one up himself.

It was only by the most arduous labour, by travel, by readiness of access to all men, by inexhaustible patience in weighing up complaint and criticism, that he learned how the law actually worked in the remotest corner of his land. He was scarcely ever a week in the same place, and with him went an army of secretaries and lawyers, mail-clad knights and barons with their retainers, the archbishop, and some of the bishops and abbots.

Many were the grumbles of Henry's travelling court. "If the King has promised to stay anywhere," wrote one of his court, "you may be certain that he will start very early in the morning and thwart everybody's plans. You may see men rushing about as if they were mad, beating their horses, driving their wagons into one another, every one in a fuss. . . . If, on the other hand, the King announces that he will set out early in the morning for a certain place, his plan will certainly be altered, and you may be certain that he will sleep till midday. Then you will see the pack-horses waiting with their burdens, the wagons standing ready, the carriers dozing, the pedlars worrying and all grumbling at one another." When at length they were making for some place the King would suddenly alter his plans and go somewhere else, where there was but one house and food for himself alone.

Henry found, however, that even he, with all his energy, could not personally settle all matters in dispute, and so he ordered that the judges of his court should go out three times a year to try criminals. This is the origin of the judges who to-day go on the assizes and tour the country.

Our jury system, the pride of England, owes much to Henry II. When two men quarrelled as to, for example, the ownership of land Henry ordered that the dispute should be settled by a jury of twelve men from the neighbourhood.

Henry enjoined also that twelve men of each

district should bring up before the judges all who were suspected of thieving and murder. This is the origin of the Grand Jury which to-day presents prisoners to the Judges at the Assizes At the beginning of the reign of Henry II it was the custom that a man should be declared innocent or guilty after a resort to ordeal. One form of ordeal was that the accused, after prayer, plunged his arm into boiling water. If the injuries were healed in a few days it was held that God had declared him innocent, but if they were not healed the man was held guilty. The Pope forbade this recourse to "the judgment of God," as it was called, and so it was decided in the reign of John that the prisoner was to be declared guilty or not by the Petty or Common Jury. This is the origin of the jury which nowadays has to decide, after hearing the evidence, on the innocence or guilt of the accused.

Henry's one-time friend was Thomas Becket, whom he promoted to be Archbishop of Canterbury, in spite of Becket's prophecy that it would break their friendship Henry, true to his principle, was determined to rule his subjects, clerical as well as lay. Becket championed the independence of the Church from the State, and many were the quarrels between them. The greatest of all was about who should punish the clergy who had committed crimes. Henry proposed that when the Church Courts had decided the guilt, the King's Courts should fix the punishment. Becket agreed, then changed his mind and urged that, as before, the Church Courts should decide the punishment. Then he fled for safety into exile.

After six years both agreed to let bygones be bygones, but Becket angered the King again on his return, and Henry, hearing in Normandy of his doings, said, in a moment of passion, "What a pack of fools have I in my Court that

FIG. 105
The First Trial by Jury

not one of them will avenge me of this one upstart priest!"

Four knights took the King at his word and made straight for Canterbury Cathedral.

"Where is the traitor Becket?" they shouted.

"Here am I," answered Becket, "not traitor, but archbishop and priest of God."

FIG. 106
An English Baron

With that they stabbed him. Henry repented and did penance, and had to give way on all points to the demands of the Church.

Henry had much trouble with his family. "Dost thou not know," Geoffrey once answered a messenger his father sent to urge him to peace, "that it is our proper nature, planted in us by inheritance from our ancestors, that none of us should love the other, but that ever brother should strive against brother and son against father?"

As Henry's sons grew up he appointed them to rule over portions of his vast empire. His theory was that they ruled under him, but their idea was that they ruled independently, and when Henry tried to enforce his view they each, in turn, allied with the King of France against him.

Henry, the eldest son, revolted before he was 20, and died before he was 30. Richard, the next son (later known as Richard the Lion-Heart), became ruler of Aquitaine and rebelled. Henry then turned to John, his youngest and favourite son, and set him over Aquitaine. Still the strife went on till Henry was driven out of nearly all his possessions in France, though he contested every inch of the ground. He grew very ill, and in this condition he had to submit to most humiliating terms. A little later a list was brought to him of those who had conspired against him, and heading the list was John.

"Let all the rest go as it will," said Henry, "I care no more for myself nor for the world," and he died muttering, "Shame, shame on a conquered King."

A conquered King in France he might be, but he was one of the makers of England.

THE IVANHOE FRIEZE CHARTS

The frieze represents a number of travellers on the road to a tournament at the time when Richard the Lion Heart was King of England.

In the frieze Richard is pictured on the extreme right with his vizor down. At the time represented he had just returned from the Holy Land, where he had been one of the leaders of the Third Crusade. (See the story of the First Crusade p. 635.) On his way back from Palestine he had been shipwrecked on land belonging to Leopold, Duke of Austria. This was unlucky, for he and Richard had quarrelled during the Crusade. Richard, realizing that he was in danger, tried to get safely through Leopold's territory by disguising himself as a merchant, but he was captured, imprisoned, and then sold to the Emperor, Henry VI.

Richard's subjects were very sorry at this, but Richard's younger brother John was glad. We see John, near the front of the frieze, throwing back his head and laughing boisterously. On his right wrist he bears a hawk, for he was keen on all the sports of the time.

When John heard that Richard was captured he set a rumour afoot in England that Richard was dead, and he and King Philip of France tried to persuade the Emperor not to release Richard.

For a long time no one in England knew where Richard was. Blondel, a minstrel who was devoted to Richard, determined that he would find him even if he had to visit every castle in Europe to do so. He went from castle to castle singing one of Richard's favourite songs. At last, when he was giving up hope of finding him, after he had sung the air outside a castle, he heard a thin voice, which he recognized as Richard's, repeating the tune. Quickly he returned to England with the information, and

the King's subjects paid the large ransom demanded to gain his freedom

Near Richard in the frieze stands a Palmer, who had been on pilgrimage to the Holy Land. We recognize him by his dress—a wide flat hat and a rough white cloak. He carries a staff with a hook to it to take his bundle, and a scrip or purse. These were always blessed by the parish priest before he started. While on the pilgrimage the palmer allowed his beard and hair to grow long. While in the Holy Land he lived on the charity of the people he met. He visited Bethlehem, Jerusalem, and the other spots made sacred because Christ lived in them while on earth. At the shrines he prayed. When he returned from Palestine he was entitled to wear a palm in his hat, and from this he gained the name of Palmer. He had so many tales to tell, of the places he had visited, the sights he had seen, and the adventures he had encountered on the way, that he was a popular figure in every social gathering.

The Knight in the frieze who wears the rich scarlet mantle on the right shoulder of which is cut a white maltese cross is a Hospitaller. He wears a flat scarlet cap to match his mantle. He may well have been with King Richard on his Crusade.

The Hospitallers originated before the Crusades. About 1050 a guest house or hospital in Jerusalem, where pilgrims could be entertained, was established by a body of Italian merchants. This hospital, dedicated to St. John, was managed by Benedictine monks. When the First Crusade was over its hero, Godfrey of Boulogne, visited the place and found that these good monks had devoted themselves during the siege of Jerusalem to the care of the sick and wounded Christians, giving them the best of all they possessed, and living themselves in the utmost poverty. Godfrey at once endowed the hospital with lands and money, and appointed its first Grand Master. A splendid church was built for them, and a dress prescribed, a black robe with a cross of eight points in white linen upon it.

Shortly afterwards the second Grand Master changed it into a military order, bound to carry on the same kind of charitable work in looking after the sick and wounded, but specially to defend the Holy Sepulchre, by force of arms. The fighting brethren were distinguished from the rest by their red surcoats with the white cross. Except for their vows to fight against the Saracen the Hospitallers were monks. No Hospitaller might call anything his own, nor might he marry.

In the front of the frieze, chatting to King John, ride two Knights Templars wearing white surcoats with red crosses on their left shoulders and coats of mail underneath. The Knights Templars were founded soon after the First Crusade by King Baldwin, the brother of Godfrey of Boulogne. Their special object was to defend the Holy Sepulchre and protect from the Saracens pilgrims who came in large numbers to the Holy Land after the First Crusade. The Headquarters of the Templars was in a building, given them by Baldwin, close to the Temple. Their most important task was fighting but they, like the Hospitallers, were vowed to a certain amount of prayer and fasting, and to poverty.

Riding beside the scarlet-clad Hospitaller is a Prior of a Cistercian monastery. He is clad in white of a material far better than the rule of his order permitted. He wears the fashionable shoes of the time with the long tapering upward points. The Cistercian order was founded in 1098 by men who were determined to lead a more self-denying life than the Benedictine monks of the period, but by the reign of King Richard they were not as strict as they had been.

Behind the Prior rides a little group composed of two Knights and a lady on horseback. Behind them is a jester, recognizable by his parti-coloured dress, his sword of lath, and the ham which he has been brandishing close to the Jew, much to the disgust of the latter. Every nobleman of rank in those days kept a jester whose business it was to entertain the company, especially in the evenings, with tales and merry quips.

Behind him rides the Jew, who, in accordance with English law at that time, was wearing a yellow hat. He is turning to look at his daughter who is being carried in a litter.

LLEWELYN THE LAST WELSH PRINCE

Llewelyn ap Gruffydd, the last Welsh Prince, became the ruler of the region of Snowdonia and Anglesey on the death of his uncle in 1246. His grandfather, Llewelyn the Great, had ruled over the whole of Wales, but in the interval between his death and Llewelyn's accession there had been family disputes, and the English had used the occasion to win back the land which they had lost.

The young Llewelyn quickly showed his greatness. By 1255 he was master of Gwynnedd, the name given to North Wales. From that time forward he won back land from the English, allying with the nobles of Scotland who were the enemies of King Henry III. When Henry III invaded North Wales hoping to conquer Llewelyn he was disappointed, for the Irish allies he was expecting did not arrive.

In spite of the jealousy of some of the nobles of South Wales Llewelyn was able to win promises of obedience from all the Welsh nobles, and by 1265 he could regard Wales as once again a more or less united Principality practically independent of England.

Then in 1272 Henry III died and Edward I became King of England. This was unlucky for Llewelyn, since part of his success was due to Henry III's weakness.

Edward sent to Llewelyn asking him to do homage for the Principality of Wales, but, though Llewelyn had done homage to Henry III at the time when he first became Prince, he at first delayed and finally refused to renew it.

War broke out between Llewelyn and Edward. Edward sent out ships to capture the daughter of Simon de Montfort, who was on her way from France to Wales to become Llewelyn's wife. She was taken and sent to Windsor for safe keeping until her future husband would do homage. Even this did not make Llewelyn yield.

Edward then determined to invade Wales. Three English armies crossed the border. Edward himself took command of the northern army which marched from Chester. A second army set out from Shrewsbury to fight in central Wales; while a third campaigned in South Wales.

Llewelyn, having no army that could withstand this overwhelming invasion, left the chieftains of South Wales to make what terms they could with the English and hurried to North Wales. He hoped that the forest land in northern Flint and Denbigh would prove an obstacle to Edward, but Edward ordered that the trees should be cut down and a good road made. A fleet accompanied the English army and, encircling Anglesey, cut off from Llewelyn the wheat and supplies upon which he was relying.

Edward crossed the Conway River and blocked up the Welsh in the mountains of Snowdonia, so that they were cut off from all food supplies and from help from outside. Llewelyn held out as long as he could, and tried to tempt Edward into the mountain passes, but in vain. At length, with the approach of winter, Llewelyn had to come down from the hills and make terms with Edward.

Edward imposed hard terms on Llewelyn, leaving to him only the Snowdon region and Anglesey, the land over which he ruled when he first became Prince. Llewelyn then went to London with some of his chieftains, and spent Christmas with the King, doing homage in full Parliament.

Several years of peace followed, but Llewelyn was unhappy at the loss of his power, and Edward's subordinates were harsh in Wales. Edward had promised that the people of Wales should keep their old Welsh law and not live by English law, but this promise was not kept, and all the good positions in Wales were given, not to the native Welsh, but to the English.

At last Llewelyn could endure it no longer and broke into revolt again. At the same time a rebellion occurred in South Wales. Edward was very angry, and determined to put an end to Llewelyn's power once and for all.

The plan of campaign was the same as before. Llewelyn retreated to Snowdon and again the mountain district was blockaded by sea and land. This time Llewelyn, fearing that he might be compelled to submit if he waited in Snowdonia too long, escaped to South Wales.

He arranged to meet near Builth the Mortimers, who had led him to believe that they

would help him against Edward. He posted his army on a mountain in the neighbourhood, took a bodyguard of eighteen, left them to guard a ford over the Wye, and went, alone and unarmed, to the appointed spot. When Llewelyn

FIG. 107
English Men-at-arms

reached the place there was no one there, and, immediately suspecting the truth that the Mortimers were traitors, rode swiftly back to the bodyguard at the ford.

Together they made with all speed for the rest of the army, the Mortimers close on their track. They crossed the bridge at Orewyn, and Llewelyn left the eighteen to guard it. The enemy came up but could do nothing against the bodyguard until at last some one told them of a neighbouring ford. A small party crossed the river by the ford and took the eighteen in the rear. The rest of the Mortimers crossed Orewyn Bridge and rode toward the army posted on the hill, leaving all the eighteen dead behind them

One of the knights on the side of the Mortimers saw a man running to join the Welsh on the mountain, and spurred after him. Overtaking him, he ran his spear through him and left him dead.

Llewelyn's army was put to flight. Then the knight returned and found that the unknown man he had slain was Llewelyn. He cut off Llewelyn's head and sent it as a present to Edward.

The Welsh were not able to find another good leader after Llewelyn was dead, and so Edward made himself master of Wales. He built castles to prevent the Welsh from further revolts, and he gave them a new Prince of Wales.

FIG. 108
A Welsh Soldier

One day he was talking to some of the Welsh chieftains in Carnarvon and he promised them that on the next day he would give them as Prince one who could speak no word of English. The chiefs pondered all night who this Prince could be, and on the next day assembled outside Carnarvon Castle. Edward was there to greet them with his wife Isabella and a nurse carrying Edward's infant son who had been born at Carnarvon during the Welsh War. Edward offered to the Welsh his infant son who could speak no word of any language, and from that time the eldest son of the King has always been the Prince of Wales.

VISITS TO THE MEDIEVAL FAIRS AT WINCHESTER AND STOURBRIDGE

We are up betimes this morning, 31st August, because this is one of the great days of the year in Winchester, the opening day of St. Giles' Fair, the second largest fair in Medieval England.

The fair belongs to the Bishop of Winchester, which means that he gains large profits from it. The first excitement of the day is provided by the procession of the Bishop's officials round the city. They are met by the mayor and the bailiffs of Winchester clad in their robes of office. The mayor ceremoniously gives up the gates of the city to the Bishop's officials. We listen to the proclamation that there shall be no buying and selling of goods within the city for the sixteen days the fair lasts.

Next we watch the Bishop's representatives and the mayor and bailiff ride out of the eastern gate of the town and up the St. Giles' hill. There

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FIG. 109

Shopping in the Fifteenth Century

This illustration shows merchants and their shops in the fifteenth century. The merchant on the left is a shoemaker. Note the pointed toe of both boots and shoes. The jeweller had placed his wares on dark cloth to show them off to the best advantage to the inquiring buyer. Behind him is his safe. On the right of the picture is the silversmith, whose shop is well stocked with silver ware for use on the tables of the rich.

they appoint a special mayor and bailiff and coroner to govern the city and the fair on behalf of the Bishop

The hill is quickly covered with booths and stalls. Every man who is not a citizen of Winchester pays to the bailiff a sum of money for the right to put up his stall or booth, which

By courtesy of *La Bibliothèque Nationale, Paris*

FIG. 110

A Lady and Her Maid on the Way to a Fair in the Early Fifteenth Century

money the bailiff later pays over to the Bishop The stalls are laid out in an orderly fashion in streets, men from the same town keeping together in the same part The Flemings are to be found in one street with finely woven, beautifully dyed cloth for sale. The men from Caen in Normandy have their stalls in another street. Men of the different trades keep together, goldsmiths in one row and cloth dealers in another. The fair is a scene of great activity, and is crowded with buyers in spite of the fact that every one who comes to it has to pay a toll to the Bishop's collector. Here we notice barons and their ladies laying in their yearly store of Flemish cloth, which is finer than the English weavers can produce. Near them is a cellarer from a neighbouring monastery who is buying the salt which is needed to salt down the meat when the cattle are killed off at Michaelmas because there is no food for them during the winter months. He buys in supplies of salted fish for the brethren to eat on Fridays and in Lent. Jostling him is a lord's bailiff laying in a store of iron goods and enough tar for the sheep to last for a year

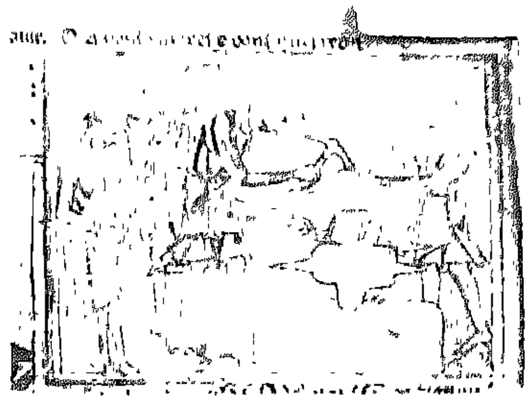

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FIG. 111

An Armourer's Forge

This shows an armourer at work making armour on his anvil. His workman looks to see whether the sword blade is true.

When so many people throng together disputes are likely to arise. In the hope of preventing them it is a rule that every purchase shall be made before an official, and a due paid on the transaction, often a penny from each party. When the wool-weigher weighs a bale of wool he charges a penny. All this money is finally handed over to the Bishop.

Even though all sales are inspected disputes arise, so there is a special law court set up for the duration of the fair, it is called "The Court of the Dusty Feet" or "The Court of Pie-Powder." Here disputes can be quickly settled by a law which is common to all the merchants of Europe. In this court, too, the weights and measures used at the fair are tested, and the bread and beer tasted to see that they come up to standard, and prices for them are fixed.

In the fair itself are booths at which those who make themselves hungry and thirsty by their bargaining can refresh themselves with pies, bread, wine, and ale.

Every evening, at sunset, the marshal rides through the midst of the fair and proclaims publicly that every trader shall immediately shut his stall and not sell any more merchandise.

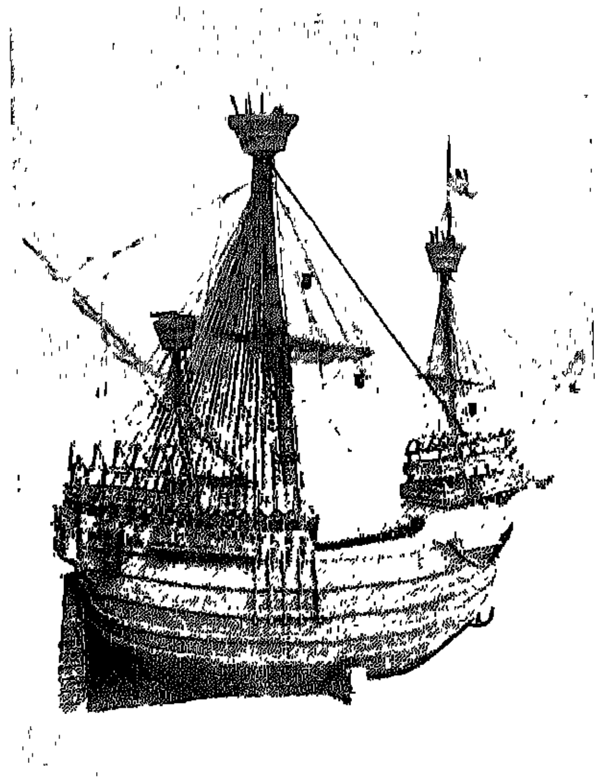


FIG. 112

Flemish Trading Vessel of the Fifteenth Century

This is the kind of vessel that the Flemings used to bring them and their goods to the English fairs.

Finally, on 15th September the fair closes, wagons and pack-horses stream back over the deeply rutted roads carrying to every corner of southern England the stores purchased by the buyers, while foreign merchants convey from the port of Southampton the wool and raw hides that England produces in such quantities, to be worked up by Continental tradesmen.

If we want to visit Stourbridge Fair, outside Cambridge, we must visit it on 4th September, its opening day, or on any day in the next three weeks. It is arranged just like St. Giles' Fair in street and quarters, but what makes it specially interesting is the large number of foreigners who bring their wares to it. There are the tall dark-skinned Venetians and Genoese, with all the products they bring from the East, gold and jewels, silks, velvets, and the famous Venetian glass. They have for sale, too, many spices from the East, which the people use to make more palatable the salted meat they eat in winter. In another quarter the shorter Flemings from Bruges, Liége, Ghent, and Mechlin have their stalls piled up with fine woollen cloths, linens, and fine lawns. Dark-eyed, fiery Spaniards are there, too, with their wines. French and even Greek traders hawk their wines, while merchants from the Far East have currants, almonds, and raisins for sale Very different from these southerners are the Norwegians, who bring pitch and tar, and the Hansards, as the men from the Hansa League towns were called, bringing furs from the Far North and amber, copper, iron, and bow staves. Sometimes they bring jewels from the East, and even porcelain from China.

About seventy towns in northern Germany and along the Baltic coast had so far united as to form a league for the furtherance of trade. These Hansa merchants were the most important international traders of northern Europe in the Middle Ages.

The chief produce which the English merchants have to sell to these foreigners is wool. The chief buyers of this are the Flemings. They take it home with them, because it is the very best wool that can be bought, and make it up into woollen cloth on the looms of Flanders. Other English merchants have for sale lead from the mines in Derbyshire, salt from the Worcestershire springs, and iron from the Sussex forges. Sometimes when the harvest is very good there is also for sale barley grown in eastern England

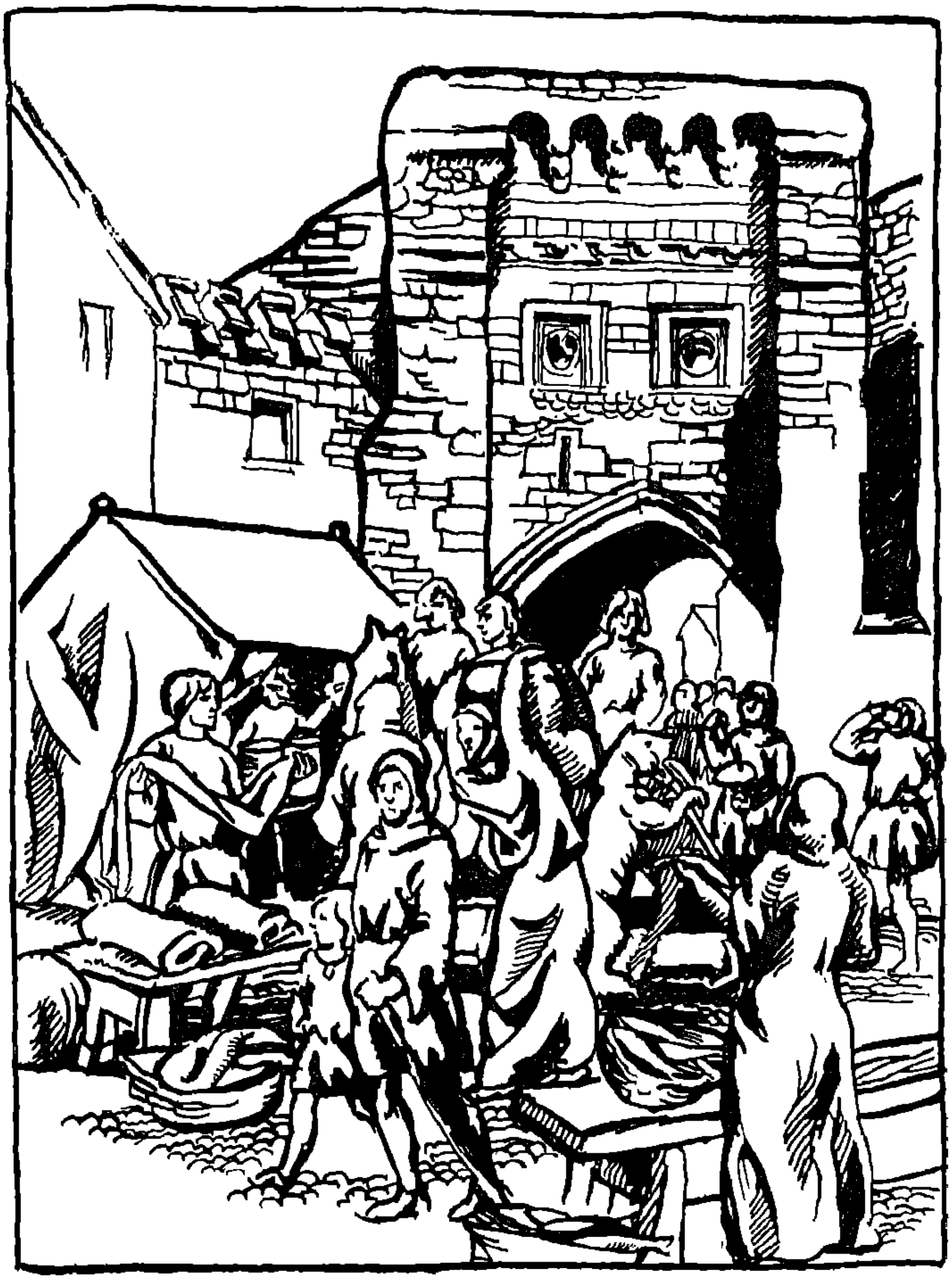


FIG. 113
Winchester Fair

HENRY V

Henry V was born at Monmouth in 1387. His father was Henry Bolingbroke, the cousin of King Richard II. Henry lived happily with his father and mother and younger brothers at Monmouth. He grew to be a handsome lad, tall and fair, and so swift of foot that he could run faster than the swiftest deer.

When he was only eleven years old he went to study at Queen's College, Oxford, living in a little room over the gateway there.

He seems to have spent only one year at College, for that same year his father was unjustly banished by King Richard II. Richard, however, was kind to the young Henry, and took him with him on his expedition to quell the Irish, and knighted him when he was in Ireland.

While Richard was in Ireland news came that Henry Bolingbroke had landed in England to reclaim the lands of which Richard had unjustly deprived him. Many of the English barons and common people rose in his favour, and they marched to Chester to meet King Richard on his return from Ireland. Richard's men fled. Richard was captured, taken to London, and made to resign the crown. Parliament chose Henry Bolingbroke as King, and he took the title of Henry IV. At his coronation his son, now known as Prince Hal, bore the sword of justice.

The picture given opposite is taken from an old stained-glass window in a house at Betley, Staffordshire (time of Edward IV probably).
The Morris Dances, the oldest unchanged English dances, are said to have been brought back by John of Gaunt (father of Henry IV) from Spain in the reign of Edward III. These very vigorous ritual dances were performed on May Day and other festival occasions by sets of six men wearing bells fastened to their knees in the Moorish fashion. The six were accompanied by a piper (9) and a fool (12) who was sometimes put to death as a climax to the dance. The dancers were sometimes accompanied by mummers dressed to represent traditional English characters such as Robin Hood, Maid Marion (a man dressed as a woman (2)), Friar Tuck (3), Little John, and Tom the Piper. The Hobby Horse (5) consisted of a painted wooden head and tail with a framework casing for the actor's body. The actor's legs were covered with cloth to represent the housings of the medieval tilting horse.
The dances were exceedingly popular in Tudor times, as they are to-day.

FIG. 114
Morris Dancers

(This deposition of Richard II by Henry IV, who was also known as Henry of Lancaster, was one of the causes of the Wars of the Roses, which began in 1455.)

The new King soon had a rebellion with which he had to deal. In Wales there lived a nobleman, called Owen Glendower, who rose in

arms. In the north of England the Duke of Northumberland and his son Harry Percy, called Hotspur, prepared for war and marched south to join Glendower. Henry IV marched out from London taking with him the 14-year-old Henry.

The two armies met at Shrewsbury, and a fierce battle took place. Prince Hal was struck in the face by an arrow, and his attendants begged him to leave the field.

"How shall our people fight," he replied, "when they see their prince recoil from fear? Bring me rather first and foremost that I may enforce their courage as it becomes a prince to do."

Toward sunset Harry Hotspur was slain, and Henry IV and Prince Hal had won a great victory. From this time forward Prince Henry was always employed either in fighting against rebels or in advising in matters of state. The picture which Shakespeare draws of a madcap Prince is not borne out by facts.

At twenty-six Henry became King, on the death of his father. His great ambition was to renew the war with France which had been begun in the reign of Edward III. The Hundred Years' War broke out because the King of France had wanted to take from Edward the land in France over which he and his ancestors had ruled. Edward had claimed that he ought to be King of France because his mother was a French Princess, all of whose brothers had died, but the French had refused to have as King one whose claims came through a woman. Henry V determined to renew the claims of Edward III, and, when the French would not agree, he declared war.

He gathered his troops at Southampton and his ships in Southampton Water. After waiting a few days for a favourable wind Henry and his men set sail and crossed to the town of Harfleur, the chief port of Normandy. To this town they laid siege for a month, using guns, battering rams, and catapults that flung stones as big as

FIG. 115

Chaucer's Canterbury Pilgrims on their Way to the Tomb of Thomas Becket

(See Vol. I, pages 176–190.) The Knight had fought in various Crusading expeditions in the reign of Edward III, and the Squire, his son, had taken part in the early battles of the Hundred Years' War in Edward III's reign

millstones. At the end of the month the citizens of Harfleur had to yield and the governor and a few of the leading men climbed up the hill outside the city to lay the keys of the town at Henry's feet. Henry then walked barefoot to

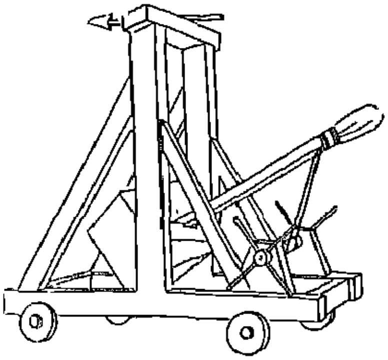


FIG. 116
Catapult

the chief church of the city to return thanks to God for the victory.

Henry then determined, though his men had suffered much from illness during the siege, that he would march to Calais, the town which the English had held ever since it had been captured by Edward III. Henry thought that if the French attacked he would have a great victory, and, if they were afraid to fight, he would have made clear his valour.

This march tried the courage of the English troops. It was a rainy autumn and the French, remembering previous English marches, had blocked the roads and broken down the bridges. Nothing could discourage Henry, and he heartened his men to continue their march. He kept his men under very strict control, hanging a man who had stolen a small golden vessel from a church.

At last they came up with the French at Agincourt. The French outnumbered the English by five to one. One of the English knights regretted that they had not there "but one ten thousand of those men in England that do no work to-day."

Henry rebuked him, saying "the fewer men, the greater share of honour." In the memorable words of Shakespeare's play, Henry the Fifth—

And Crispin Crispian shall ne'er go by,
From this day to the ending of the world,
But we in it shall be remembered ;
We few, we happy few, we band of brothers ;
For he to-day that sheds his blood with me
Shall be my brother ; be he ne'er so vile,
This day shall gentle his condition :
And gentlemen in England now abed
Shall think themselves accursed they were not here,
And hold their manhoods cheap whiles any speaks
That fought with us upon Saint Crispin's day.

The French army spent the night in revelry, but the English in soberly thinking of the fight to take place on the morrow. Henry's position was good since on both flanks he was protected

FIG. 117
Isabella of France, Mother of Edward III

by woods. In the front Henry set his archers, and behind them his men-at-arms.

He passed among his men saying a cheering word to each. With a great cry of "St. George"

the English advanced As soon as the English saw that they had urged the French on to the

By courtesy of La Bibliothèque Nationale, Paris

FIG. 118

A Longbowman

attack they halted and planted their stakes in the earth. The English archers poured their arrows into the advancing horsemen, who came on slowly, borne down by the weight of the armour covering both horse and man, and sinking in the sodden ploughed land. The cavalry retreated before the shower of English arrows.

Then the French men-at-arms advanced, but they sank in the heavy ground, weighed down by their armour. Each English arrow told. Finally, the English drew their axes and knives and advanced upon the remainder of the French army.

An English victory seemed assured when the news came that a French division had attacked the English rear. The King ordered that every prisoner should be put to death. Later he discovered that the French in the rear were merely plunderers. At the end of the day the French had some ten thousand slain, while the English had lost but two hundred men.

Henry and his army after this mighty victory marched on to Calais, and then crossed to England. Great crowds flocked to meet them at Dover, and they were welcomed with shouts in London.

Still, Henry had not made the French yield. After two years he went back to France again, and finally it was agreed that Henry should marry the French King's daughter, Katherine, and that, on the death of the King, Henry V should rule France as well as England.

However, Henry was worn out by all his activities and died before the French King. He was buried in Westminster Abbey, and is remembered as one of the most heroic of English Kings.

FIG. 119

Fifteenth Century Costume

This is the kind of dress which was worn at the time when Henry V was winning his victories in France.

CARDINAL WOLSEY

Thomas Wolsey was born at Ipswich in 1471. His father, so Wolsey's enemies in later life said, was a butcher, but it seems more probable that he was a sheep farmer and wool merchant.

Wolsey was so clever a pupil that at the age of 11 he was sent to the University at Oxford, where he took his B.A. Degree at 15, at least two years earlier than most youths of the time gained it. On this account he was known as "The Boy Batchelor." He was elected Fellow of Magdalen College, Oxford, and as soon as he had taken his M.A. Degree he was appointed master of a school attached to this college. Soon afterwards the father of some pupils of his presented him with a living in Somersetshire.

Wolsey was ambitious and the quiet work of a country parson did not satisfy him. After a time he became one of the chaplains of King Henry VII. This did not mean that he took services in church. He was chiefly occupied as a kind of secretary to the King's officials. So useful was he that the King made him Dean of Lincoln.

Henry VIII became King on the death of his father Henry VII. The new King was young and full of ambition, and he was quick to notice Wolsey's ability and to make him his chief minister. To reward him Henry gave Wolsey the Bishopric of Lincoln, and shortly afterwards made him Archbishop of York. The Pope at the request of Henry added the title of Cardinal and made Wolsey Papal Legate.

Wolsey now lived in great style. His household comprised five hundred people. He dined in state, entertaining daily all who came to do business with him. His servants were clad in the finest livery, and Wolsey himself looked magnificent in his red Cardinal's robes.

English noblemen and ambassadors from abroad realized that he was the real ruler of the country, since as yet Henry VIII was too much interested in other matters to give his full attention to the dull routine of government. The Venetian ambassador said of Wolsey—"He is the person who rules both the King and the entire Kingdom. At first he used to say: 'His Majesty will do so and so'; afterwards by degrees he began to say: 'We will do so and so'; and now he has reached such a pitch that he says: 'I shall do so and so.'"

Wolsey was anxious that foreign countries should be impressed with the importance of England. At that time there were two young rulers in Europe, Francis I of France, and the Emperor Charles V who ruled over Germany, Austria, the Netherlands, Spain, and part of

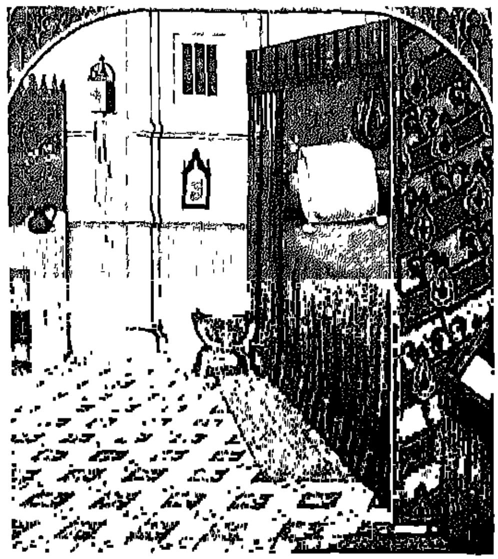


FIG 120

A Sixteenth Century Room

This shows the kind of bed which Wolsey and other rich men of the time used Recess beds of this type are still in use in Austria

Italy. Each was striving to gain more power than the other, and Wolsey's policy was to ally, but not too definitely, with the weaker so as to lessen the power of the stronger.

It was at this time that Henry and Francis I had a splendid meeting at "The Field of the Cloth of Gold," near Guisnes, which is not far from Calais. Nearly three thousand tents were set up on the plain, and each knight, whether French or English, strove to make his tent and its furniture and his clothes and armour more splendid than that of any one else. For twenty days the two Kings and their noble attendants spent their time jousting in tournaments, while

their followers engaged in wrestling and shooting matches.

The Kings held costly banquets, and gave each other rich presents They promised to live in great friendliness, but both before and after the meeting Henry and Wolsey met Charles V secretly.

Among those present at the Field of the Cloth of Gold none made a more impressive figure than Wolsey, but there were many English nobles who hated him. They were jealous that a man not of noble birth should have so much influence over the King and should be so wealthy. Wolsey, too, was perhaps a little haughty in his dealings with people. The envy and hatred of the nobles did not harm Wolsey so long as the King was his friend, but next Henry began to turn against him.

It happened in this way. Henry had married Catherine of Aragon, the aunt of Charles V, but, though she made him a good wife, he was becoming tired of her. Then he saw Anne Boleyn, one of the ladies in attendance on the Queen, a lady with bright black eyes and wonderfully long hair. Henry fell in love with Anne Boleyn, and nothing would satisfy him except that he should put away Catherine and marry Anne.

Henry asked the Pope (the ruler of the Catholic Church, who lived at Rome) for permission to do this, but the Pope was in a difficulty. A previous Pope had granted Henry permission to marry Catherine, and the present Pope could hardly go against his predecessor's opinion. Again, the Pope was a prisoner in the power of the Emperor Charles V, and the Pope dared not offend him by allowing Henry VIII to put away Charles's aunt Catherine. On the other hand, the Pope did not want to offend the powerful Henry. As a way out of the difficulty he sent Cardinal Campeggio to England to try the case with Wolsey, giving Campeggio secret instructions to drag out the case as long as possible.

Now Wolsey had tried by every means in his power to persuade Henry to give up his scheme of marrying Anne Boleyn, but without success. Wolsey, therefore, in loyalty to Henry, did his best to carry out the King's wishes, but when Henry found that he could not have his own way quickly in getting rid of Catherine he blamed Wolsey, and in his fury took from him the office of Chancellor, his palaces at York and Hampton Court, and almost all that he had.

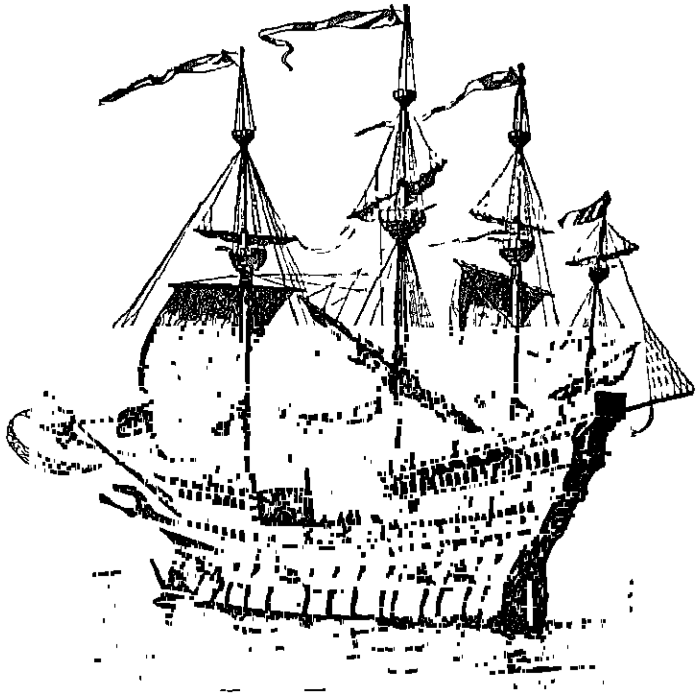


FIG. 121

Ship of Henry VIII

This is the kind of ship in which Henry VIII and Wolsey crossed the Channel to go to the meeting of the Field of the Cloth of Gold

Wolsey retired to his house at Esher and there he fell ill. The King was sorry when he heard this news and sent his own doctor to him. "I would not lose him for twenty thousand pounds," he said.

"Then," said the doctor, "Your Grace must

send him some comfortable message as shortly as possible."

Henry took from his finger a ring which Wolsey had once given him and said, "Tell him that I am not offended with him in my heart nothing at all, and that shall he perceive, and God send him life very shortly."

When Wolsey grew better the King granted him a full pardon, but commanded him to go north to act as Archbishop of York. In this capacity he worked very hard, visiting the sick, confirming children, and winning from all golden opinions.

Wolsey's enemies, however, were still busy, and they accused him falsely of having written treasonable letters to the King of France. Henry, in wrath, sent north the Earl of Northumberland. Wolsey, not knowing his errand, received him kindly.

"My lord, I arrest you of high treason," at length said Northumberland.

This was a terrible shock to Wolsey, who for some time could say nothing. A few days later he set out with Northumberland for London. The Yorkshire people shouted after him, "God save your Grace."

Wolsey's health had been failing for some time, and this accusation made him still more ill. At length he reached Leicester Abbey.

"Father Abbot," said he, "I am come to leave my bones among you."

The next day he was much worse, and the day after that he died.

"If I had served my God," said the dying Wolsey, "as I have served the King, He would not have given me over in my grey hairs . . . I pray you to have me most humbly commended unto His Royal Majesty . . . He is sure a Prince of a royal courage, and hath a princely heart; and rather than he will either miss or want any part of his will or appetite, he will put the loss of one half of his Kingdom in danger: for I assure you I have often kneeled before him in his privy chamber on my knees the space of an hour or two, to persuade him from his will and appetite, but I could never bring to pass to dissuade him therefrom."

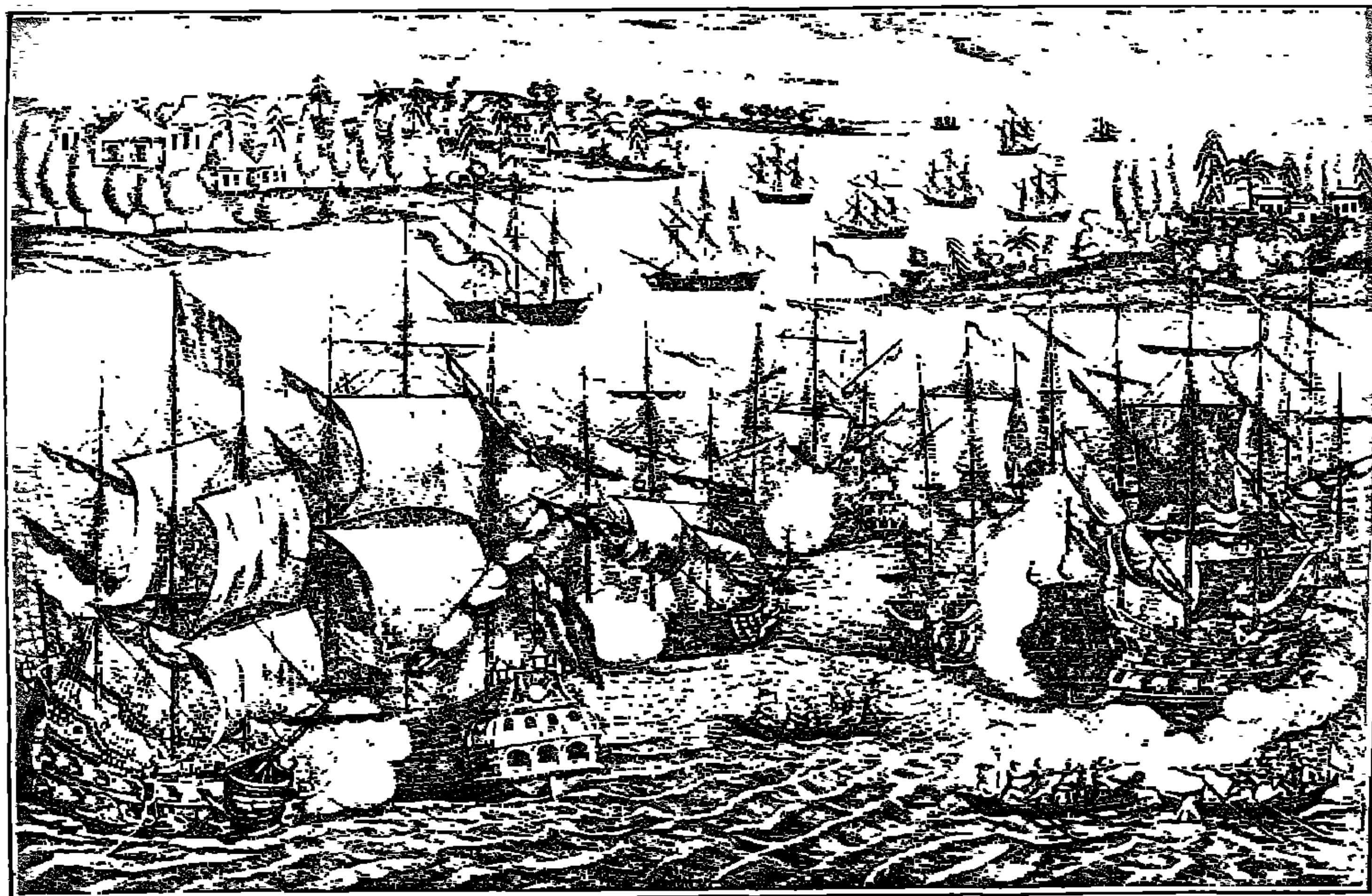
Next day Wolsey was buried in the Abbey.

By courtesy of *T. Foster Knowles, Esq*

FIG. 122

"Clouds that Gather Round the Setting Sun"

(After Seymour Lucas, R.A.)



Lx c ur x o/ The British Museum

FIG. 123

Battle between 2 East India Ships and 4 Portuguese Galleons and 24 Frigates, 1612

This battle lasted three days. The East India Company was incorporated by Queen Elizabeth in 1600. As in the American and South African colonies, there was constant rivalry with other European powers. The governing power of the company was taken over by the British Government in 1858, and Queen Victoria was proclaimed Empress of India (see p. 720)

CHARLES I: CAVALIERS AND PURITANS

Charles I was the son of James I. On the death of his father, in 1625, Charles became King of England and Scotland. Charles was courteous and dignified in manner. He had been carefully educated and was widely read. He specially liked reading the plays of Shakespeare and books about religion. He was keenly interested in music and painting. Before the Civil War he had the best collection of pictures in Europe.

Charles was a deeply religious man. He was a member of the Church of England, and he liked

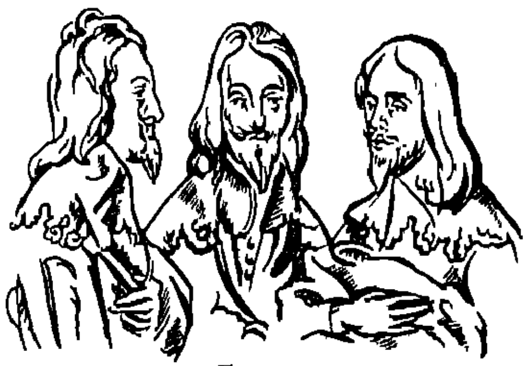


FIG. 124
Charles I
(Drawn from a portrait by Van Dyck)

to worship in a beautiful church, with stained glass windows, to hear the organ pealing, and the choir singing beautiful anthems. He wished the clergy to wear surplices instead of black gowns, and to make the sign of the cross on children's heads when they baptized them.

He thought that it was not wrong for people to enjoy themselves on Sunday after they had been to church. He liked his subjects to dance round the maypole in spring, and to dance morris dances on the village green, and to practise archery, leaping, and vaulting.

Charles always wore beautiful clothes. His coats, of good material and bright rich colours, fitted fairly closely to his figure. The sleeves were slashed or cut so as to show the shirt beneath, and they were edged at the wrist with fine lace. The collars he wore were of exquisite lace. The breeches he wore were wide, but not padded. He wore leather boots which were very wide at the top. In the open air he wore a wide brimmed hat with a sweeping feather, and a cloak.

Charles believed that a King should decide whether the English should fight or make peace with their neighbours, that he should appoint his ministers, and that Parliament should give him the money he needed for the government of the country *without criticizing what he did.* He believed in "The Divine Right of Kings," that is, he believed that he must answer to God for his actions, but that it was a sin against God for any of his subjects to question what the King did.

Members of Parliament thought otherwise. When Charles asked them for money for a war they granted only a very small amount. Next year, when the English fleet had been defeated, Parliament asked Charles to get rid of his adviser Buckingham, of whom he was very fond. Charles replied haughtily, "I would not have the House to question my servants, much less one who is so near to me."

A little later Parliament drew up the "Petition of Right," which contained a list of the high-handed acts that Charles had committed, and pointed out that these were contrary to the law of England. After doing everything in his power to avoid signing it, he gave his consent to it, and promised for the future to govern better.

A little later Charles dissolved Parliament, and for eleven years ruled without one, relying on two friends of his for advice, Archbishop Laud and the Earl of Strafford. At the end of that time he was obliged to call a Parliament because he needed money for a war with Scotland. The members of Parliament, instead of granting the money declared that Strafford was guilty of treason, and demanded that Charles should have him put to death.

Charles could not make up his mind what to do. Strafford was his close friend, and all that he had done had been in the service of the King. Charles had promised Strafford that no one should harm him Yet, outside the palace the mob threatened that, if Charles protected Strafford, he and his Queen, Henrietta Maria, should die.

At last Charles agreed to Strafford's death. When Strafford heard his fate he said bitterly, "Put not your trust in princes, nor in any child of man, for there is no help in them." Bravely he went out to be executed on Tower Hill.

"I thank God," he said as he took off his doublet at the scaffold, "I am not afraid of death, but do as cheerfully put off my doublet at this time as ever I did when I went to bed."

Parliament was not satisfied by the death of Strafford but drew up "The Grand Remonstrance," which contained a list of all the evil deeds that Charles had done, and a plan for governing England better. Some members thought that this was going too far against the King, and so The Grand Remonstrance was very hotly discussed. All night long the debate went on, the members clutching their swords at times. At last it was passed by eleven votes.

Shortly afterwards Charles heard that the Parliament were about to attack his wife, Henrietta Maria, to whom he was devoted. He, therefore, went hastily to the House, followed by soldiers. These he left outside the door. Then he strode up to the Speaker of the House of Commons and asked if the five chief enemies of the Queen were present.

FIG. 125
Puritans

"May it please your Majesty," said the Speaker, falling on his knees before the King, "I have neither eyes to see nor tongue to speak in this place, except as the House is pleased to direct me."

"Well, well!" Charles answered angrily, "'Tis no matter. I think my eyes are as good as another's." He looked round with an angry

stare, and added "Since I see that my birds are flown, I do expect from you that you will send them to me as soon as they return hither: otherwise I must take my own course to find them."

With that he departed. The five members, knowing that the King was coming, had slipped out of London by the river.

By this time it was clear that Charles was determined to have his own way, and Parliament was resolved to check him. The result could only be civil war.

Those who supported the King in the war were called Royalists or Cavaliers. Like Charles they were devoted to the Church of England. They agreed with him that it was the King's business, rather than Parliament's, to govern the country. They believed that there was nothing wrong in the amusements of the time, dancing, card playing, visits to the theatre, and the wearing of gay clothes.

Those who attacked the King were the Puritans. They were deeply religious people. They did not wish to use the services set out in the Book of Common Prayer, but they preferred that the minister should make up the prayers he used. They believed that beautiful churches and stained glass windows and music made it difficult to worship God, so they held their services in very plain buildings.

They kept Sunday very strictly, holding it wrong to do anything on that day but read the Bible. They thought it wrong to indulge in amusements of any kind.

The clothes they wore were very simple. The men wore tall beaver hats without any feather. They kept their hair cut so close that they got the nickname of Roundheads. Their collars and cuffs were of plain white linen without lace, and they had no trimming on the dull grey, brown, or black suit. Instead of the wide boots worn by the Cavaliers the Puritans wore broad fitting shoes adorned with a plain silver buckle. Puritan women wore equally plain clothes of grey with unadorned collar and cuffs, and a large white apron.

In their way of speech the Puritans were precise. They would give no man a title of respect and used "Thee" and "Thou" where others used "You." They carefully avoided swearing, and quoted many Scripture texts in their talk.

Above all, the Puritans were determined that the King should not do just as he pleased, but that Parliament should rule the country.

The great Puritan leader was Oliver Cromwell. He was a man of good birth and means who lived as a gentleman farmer. In Parliament

FIG. 126

Oliver Cromwell

he opposed the King. When war broke out in 1642 he was forty-three. He made it his business to raise a good troop of men for Parliament called Ironsides. "I raised such men as had the fear of God before them. and from that day forward they were never beaten." He drilled his men constantly in the use of arms and in the management of their horses Cromwell proved himself to be a wonderful general, and after a series of battles defeated Charles.

On various occasions terms were offered to Charles. He might have been restored if he had been willing to give up the Church of England, but he refused. While Charles and Parliament were trying to come to terms it was clear that Charles was not to be trusted, as he thought it right to make promises that he did not mean to keep. At last Cromwell and Parliament decided that Charles must be tried as a tyrant, a traitor,

and an enemy to his people. Charles asserted that they had no right to try him, and refused to plead his case. On the fifth day of the trial he was sentenced to death.

Four days later a scaffold was erected in front of Whitehall. Charles on the previous day had taken a touching farewell of his two children who were still in England. It was a cold January morning when Charles walked to the block and was executed

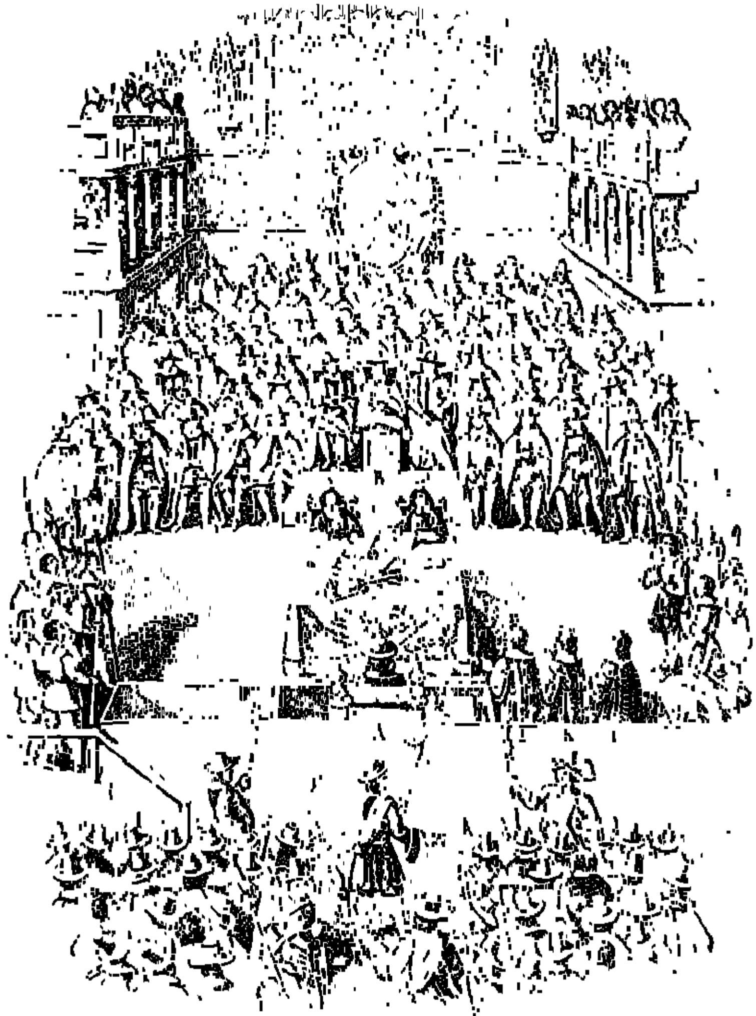


FIG. 127

Trial of Charles I

From an old print of 1684

Key to the above plate—A The King. B The Lord President Bradshaw. C and D John Lisle and William Say, Bradshaw's assistants. E and F Andrew Broughton and John Phelps, Clerks of the Court. G and H Oliver Cromwell and Henry Martin, with the Arms of the Commonwealth over them. I, K, and L Counsellors for the Commonwealth

He nothing common did, nor mean,
Upon that memorable scene,
But with his keener eye
The axe's edge did try.

Nor called the gods with vulgar spite
To vindicate his helpless right,
But bowed his comely head
Down, as upon a bed.

Charles was dead, and the English turned to Cromwell to govern the country. Cromwell did everything in his power, but he could not agree with the various Parliaments that were called while he was Protector, and it became obvious that Cromwell ruled because he was the leader of a successful army.

He was offered the title of King but that he refused. When he died in 1658 his son was made Protector of England, but he was quite unsuited for his high position On 29th May, 1660, Charles I's son, Charles II, who had had a series of hairbreadth escapes before he managed to get away from England, was restored and acclaimed as King, while the joy bells pealed in London.

Dates to Remember

The beginning of the Civil War	1642
The execution of Charles I	1649
The restoration of Charles II	1660

JAMES WOLFE

James Wolfe was born in 1721 at the Vicarage, at Westerham in Kent. He was a plain little boy, thin, tall, pale, red-haired, his only redeeming feature lively blue eyes. As James grew up he often heard tales of the army, for his father was a general.

When he was aged fifteen a messenger came riding to his home (there were no postmen in those days) bearing a letter to him. It was his commission as second lieutenant in the Marines. In Germany he fought bravely at the Battle of Dettingen, in which he had a horse shot under him. King George II was present at the battle and took part in the fighting.

Then news came that Bonnie Prince Charlie had landed in Scotland and was winning victories there against George II's army. Wolfe was sent to Scotland and fought in the Battle of Culloden Moor, in which Bonnie Prince Charlie's troops were defeated so severely that they could not fight again.

The place, however, where Wolfe distinguished himself was neither Germany nor Scotland, but Canada. In Wolfe's youth Canada belonged to the French, who had long had settlers there. In the south of what we now call the United States, beside the mouth of the Mississippi River (see Fig. 68, page 649), the French had made another colony, Louisiana. Beside the coast of the United States were the thirteen English colonies. The French wished to drive the English out of America, but the English were determined to stay there. In 1756 the two countries, France and England, declared

FIG. 128

Early Eighteenth Century Milkmaid

By courtesy of — The British Museum

FIG. 129

A Dutch Family at Home, in the year 1673

In 1689 William of Orange and his wife Mary (eldest daughter of James II) were offered the British throne, owing to the unreasonable conduct of James II, whose grandson, Bonnie Prince Charlie, tried unsuccessfully to regain the throne.

By courtesy of — The British Museum

FIG. 130

Interior of a Coffee House, 1710

(This is a contemporary print, during the reign of Queen Anne, grand-daughter of Charles I After her death George I, great-grandson of James I, founded the Hanoverian Dynasty)

war, which is known, from the length of the time it lasted, as "The Seven Years' War."

In England the chief minister was William Pitt. He sent out General Amherst to capture the fortress of Louisburg which the French had built on a large island near the mouth of the St. Lawrence River. Among those who went with Amherst was Wolfe, who by this time had risen to the rank of Colonel.

Wolfe was a wretched sailor, and was very ill during the voyage across the Atlantic, which in

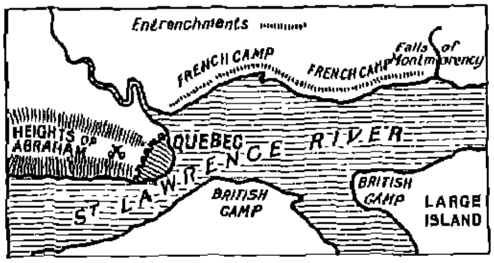


FIG. 131
Map Illustrating the Siege of Quebec

those days of sailing ships took nearly three months. As they drew near to Louisburg Amherst saw that it was a very strong fort well defended with cannon.

The first difficulty was to find a way to land the English troops. Amherst chose Wolfe to see to this as he already had the reputation for being the bravest and most daring of the officers. Then, for three weeks the English soldiers in their bright red coats and three cornered hats besieged the town, peppering it with cannon balls day and night. At last a man came to the gates carrying a white flag of truce. Louisburg was captured. Shortly after this Wolfe returned to England.

The next year Pitt planned that the English should capture the town of Quebec, the most important city that the French had built in Canada, and for this very difficult task he chose General Wolfe, because he had distinguished himself at the capture of Louisburg the previous year.

The city of Quebec stood on the banks of the River St. Lawrence, about 300 miles away from the sea. Wolfe and his men crossed the Atlantic again and sailed up the St. Lawrence River until they came to a large island opposite to the city of Quebec. Here Wolfe ordered that his men should disembark and make a camp.

Quebec was extremely well fortified, and so was the northern bank of the river as far as the falls of Montmorency. Wolfe's first plan was to cannonade the city, but this proved to be without effect. An effort to cross the Montmorency river and take the French in the flank likewise

FIG. 132
James Wolfe

failed. Meanwhile Wolfe fell ill, and it seemed as though the English would fail to capture Quebec.

At this juncture news was brought to Wolfe that above Quebec there was one place where men could with difficulty climb up the Heights of Abraham which dominated the town. If the English could climb the heights they would threaten the city and force the French to fight in the open.

Wolfe accordingly gave orders that some of his men were to stay on the island opposite Quebec, and keep up a vigorous cannonading to make it appear that an attack was just about to be launched from there. Then Wolfe and the bulk of his men, under cover of the darkness, embarked in little boats. With muffled oars and in dead silence the little boats were rowed up the river towards what has since been named Wolfe's Cove.

Wolfe, knowing that the French sentries on board ship would be likely to hear or see them, sent in front a Highland regiment among which were some soldiers who spoke French perfectly. When the challenge rang out they replied, and

the French imagined that they were French boats.

Wolfe, as he was borne up stream, repeated Grey's "Elegy in a Country Churchyard," and added that he would rather have written that poem than capture Quebec on the morrow.

Wolfe and his men landed at the cove, and then in single file made their way up an almost perpendicular cliff by a little track made by a stream in winter. Scrambling up this, and clinging to the brushwood on both sides, they reached the top. There were one or two sentries on top of the cliff, but they were not keeping a sharp look out, since the French thought it quite impossible for anyone to climb the heights. Thus caught unprepared they were quickly overpowered, and so did not give the alarm to Montcalm, the French general.

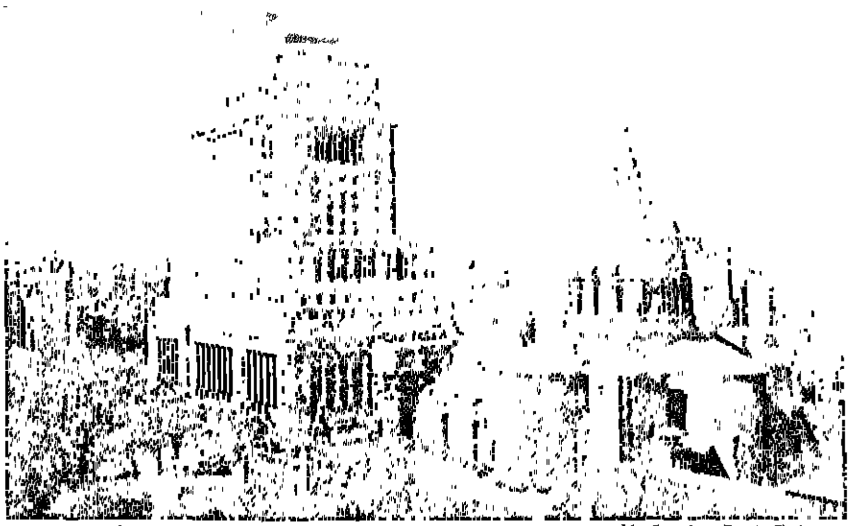
When the morning came Montcalm saw that Wolfe and his men and one gun were posted on the Heights of Abraham, and marshalled his soldiers to fight the enemy.

Wolfe ordered his men to reserve fire till the enemy came within forty yards, so that every shot should be deadly. Almost at once Wolfe was wounded in the wrist, but of this he took no notice. Again he was hit but he pressed on. A third shot made him stagger.

"Support me," he said to one of his men, "lest my gallant fellows should see me fall."

He was carried to the rear.

"They run! See how they run!" shouted an officer as Wolfe lay dying.



By courtesy of *The Canadian Pacific Railway*

FIG. 133

Montreal, from Windsor Station

"Who run?" asked Wolfe.

"The enemy, sir. They give way everywhere."

"God be praised. I now die in peace."

A few hours later Montcalm too died, and the English marched into Quebec. The next year the English captured the other important town in Canada, Montreal, and by the peace treaty which concluded the Seven Years' War the French ceded Canada to the British. From that time forward Canada has been part of the British Empire, and the descendants of the French who lived in Quebec and Montreal, though they speak French, are loyal to Britain.

Statues erected to Wolfe may be seen in Greenwich Park in London, and at Westerham in Kent.

HORATIO NELSON

Nelson was born at Burnham Thorpe in Norfolk. When he was a tiny boy he once said, "Fear, Grandmama, I never saw fear. What is it?" Since his family was poor, Horatio, though delicate, was sent to sea when he was but thirteen years old.

He quickly showed the fearlessness for which he became famous, for he volunteered as captain's coxswain in a ship bound for the Arctic Sea. One day in a fog he left the ship. When night came on he was attacked by a bear on the ice. His musket missed fire and he was in danger, when a cannon fired from the ship frightened the bear away. Although at daybreak a signal was made from the ship that he should return he did not heed it until the bear was killed, and then made the excuse for his disobedience that he "wanted to carry the skin to his father."

Soon after this he became a captain and commanded a warship in the Mediterranean in the war against the French Revolution. On one occasion when he was besieging a town in Corsica a cannon ball struck the ground near him and drove the sand into one of his eyes. He lost the sight of that eye

The war with France continued, and Nelson took part in the great battle of Cape St. Vincent against a Spanish fleet double the size of his own. In the course of the fight Nelson's men jumped aboard the nearest Spanish ship and captured it, after a struggle with the crew. Another man would have been satisfied with what he had already done, but Nelson was determined to take another ship. Shouting to his men "Victory, or Westminster Abbey," he leaped on to it, and soon this ship was captured too. This was the first exploit that made Nelson the hero of the English people.

A little later Nelson made an attack on Teneriffe, and here his right arm was torn off by a cannon ball. "Tell the surgeon to make haste and get his instruments. I know I must lose my right arm, so the sooner it is off the better," was all that he said. Nelson after this

By courtesy of *The Victoria and Albert Museum*

FIG. 134

Nelson on Board his Ship Receiving Swords of Defeated Enemies, 1793

always wore the right sleeve of his uniform pinned across his breast. Shortly after he had lost his arm he said, "A left-handed Admiral will never again be considered as useful: therefore, the sooner I get to a very humble cottage the better, and make room for a better man to serve the State." Other people realized, however, that Nelson was the best admiral that any fleet could have.

Nelson had to defeat the schemes of Napoleon. Napoleon had set his mind on conquering Egypt as a half measure toward driving the English out of India. The French fleet slipped out of harbour without Nelson's knowing its direction. Nelson guessed that it would make for Egypt, so clapped on all sail to catch it up before it reached harbour. He made such speed that he reached the coast of Egypt before Napoleon, and, thinking that his conjecture as to Napoleon's destination was wrong, he doubled back as far as Malta. There he received information that Napoleon had after all sailed for Egypt.

Making all sail, Nelson did not arrive in time to prevent Napoleon's disembarkation, but he quickly discovered that the French had not anchored their fleet as they should have done Nelson saw that it was possible for ships to sail closer to the coast than the line where the French were moored, and he, therefore, ordered that the English should attack in double file, half sailing between the French ships and the coast, so as to attack their ships in the van on both sides at once.

During the battle the French flagship *L'Orient* caught fire, and when the flames reached the powder magazine the ship blew up. At last of the seventeen French ships but four escaped.

In this battle Nelson was wounded in the forehead When he was carried down to the cockpit the surgeon hurried to attend to him, but Nelson said, "No, I will take my turn with my brave fellows."

The result of this victory was that Napoleon, though he had won a great battle on land in Egypt, could do nothing Nelson became the popular idol of the British people

Shortly after this, Russia, Prussia, Sweden, and Denmark formed a league against the British, and Admirals Parker and Nelson were sent to seize Copenhagen and beat the Danes There followed the Battle of the Baltic

At one stage in the fight it seemed that Nelson must be beaten, and Parker gave orders that he should cease action. Nelson was determined to go on, so putting his telescope to his blind eye he said, "Really I don't see the signal. Keep mine for close battle flying. That's the way I answer such signals Nail mine to the mast!"

Nelson's disobedience was justified, for shortly afterwards the Danish fleet flew the white flag.

By this time Napoleon saw that the only way to subdue the nations on the Continent was to conquer Britain, and that to do this he must land an army in England. He, therefore, collected a splendid army at Boulogne, and had built a fleet of flat-bottomed boats to carry his men to Britain. He realized, however, that unless they were guarded by the French men-of-war they were liable to be sunk in mid-Channel by the British. Unluckily for him, the French fleet was separated and blockaded by English admirals in the harbours of Brest and Toulon.

Nelson spent twenty-two months watching the French in Toulon harbour. It was a very trying time for every one concerned. The men could never go ashore. Nelson would not go either. His care for the comfort of the sailors was unending, and there was little illness in his fleet in consequence. He found out the little things that annoyed the sailors and had them altered, and discovered the little things they would like and had them done. The result was that the men worshipped Nelson. "Our Nel," the sailors said, "is as brave as a lion and as gentle as a lamb." At length the French came out from Toulon and the Spanish fleet came out of Cadiz, and the two fleets sailed with all speed to the West Indies, and then, according to Napoleon's plan, they were to return to British waters and convey the troops waiting at Boulogne over to Britain

Nelson speeded after them to the West Indies and then, discovering that they had returned, returned after them Finding that he could not overtake them he chose out the fastest brig in his fleet to convey the news of the enemy's whereabouts to Britain

The captain of the brig reached the Admiralty

one night at eleven o'clock. Lord Barham, an old man of nearly eighty, had gone to bed, and no one dared wake him. Next morning Lord Barham was furious at the delay, but within half an hour he had made up his mind what to do. Without waiting to dress he drafted instructions, which by 9 a.m. the Admiralty messenger was carrying to Portsmouth, for the English Channel fleet to attack the French fleet.

The two fleets met and an indecisive action resulted. Then the French admiral put into Cadiz harbour. Napoleon in disgust gave up the idea of invading England, and used the troops collected at Boulogne for a campaign against Austria.

Nelson, after a short space of time at home, set sail in the *Victory* to deal with the French fleet. The French admiral at length put to sea again with the combined French and Spanish fleets, making for the Straits of Gibraltar. Nelson determined to intercept them.

The British attacked, approaching the centre of the extended enemy line in two columns, one headed by Nelson in the *Victory*, and the other by Collingwood in the *Royal Sovereign*. Nelson's flag signal to his fleet was "England expects that every man will do his duty." The battle was soon joined, and the fury of the French attack fell on the leading ships. Nelson, with the stars of his four Orders on his breast, paced up and down the deck of the *Victory* till he was struck down. As he was carried below he spread his handkerchief over his face so that his men might not recognize him and be grieved.

Meanwhile the battle raged, until by the end of the afternoon the English had taken eighteen prizes. Till the last Nelson kept up inquiries as to the progress of the battle. He lived long enough to know that it was a great British victory and then, dying, he said, "Thank God, I have done my duty."

When the news of the Battle of Trafalgar reached England the people felt that they had paid far too high a price for the victory in the death of the Admiral. They were wrong, for Nelson had not died till his work was done. The navies of France and Spain were shattered, and never again during the remainder of the Napoleonic War did the enemy venture to fight at sea. Britain was quite safe from the landing of a French army, and finally was able to crush Napoleon. (See pp. 655–7)

Note Nelson's Column in Trafalgar Square, London, and the preservation of the *Victory* at Portsmouth.

THE INDUSTRIAL REVOLUTION

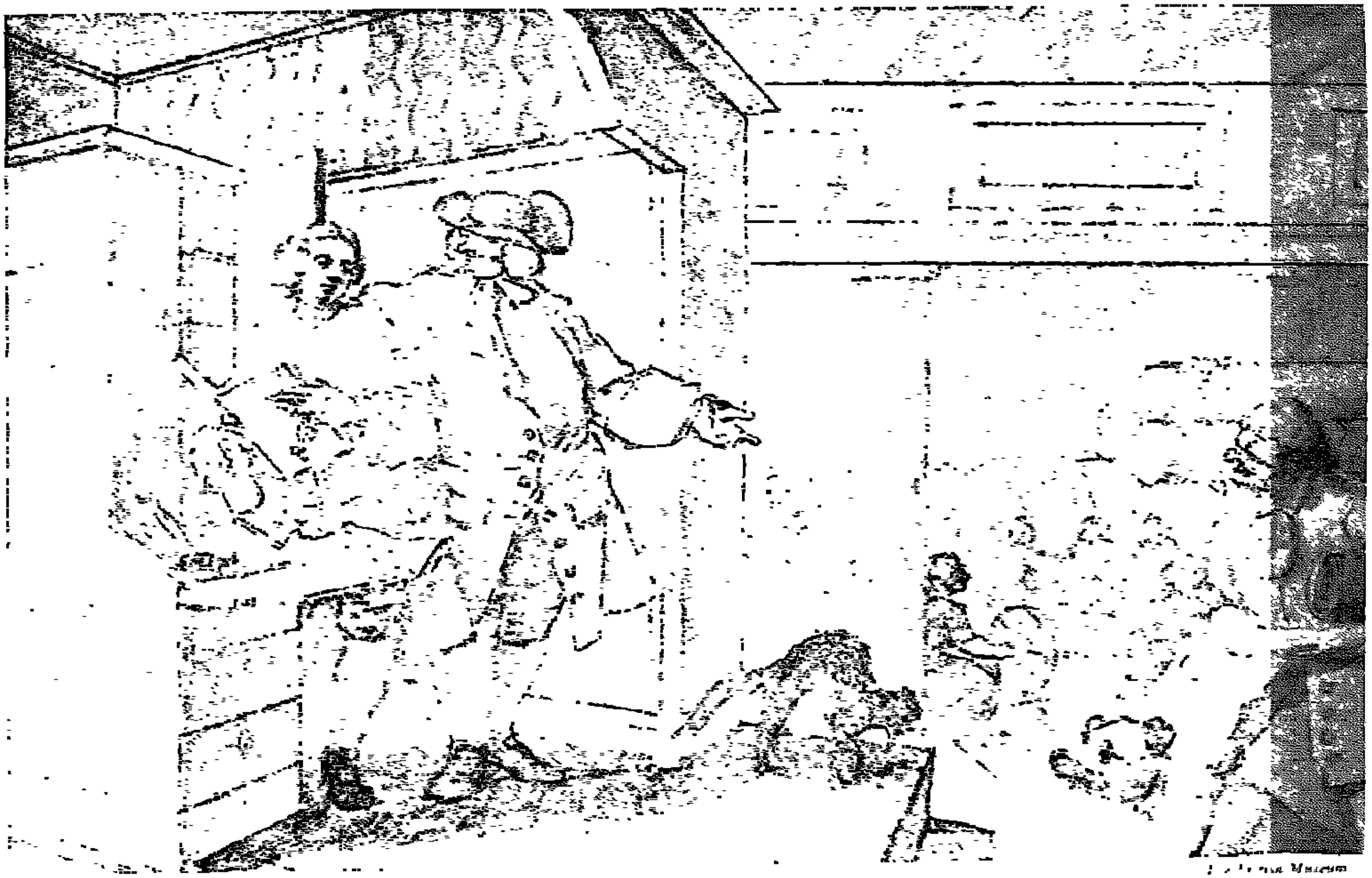
Before 1750 most people in England dwelt in the country and earned their livings by farming. The towns were, compared with modern towns, small, and they had grown up as market towns, that is as places where the villagers could sell their sheep, cattle, butter, and eggs, and buy what they needed.

Before 1750 industries were carried on in a small way, in houses that were also shops. Spinning and weaving were cottage industries. Most women had in the house a spinning wheel, and in the time left over from managing the house made extra money by spinning. It was a slow process, for only one thread could be spun at a time. The weaving was done on looms, the shuttle carrying the weft being passed from one hand of the weaver to the other on its way through the warp. In 1733 Kay invented a *flying shuttle*, a shuttle which could be thrown from side to side by the mere pulling of a string.

After 1750 there came a series of inventions in the textile trade. Hargreaves in 1764 invented a *spinning jenny* by which eight threads could be spun at one time. Next Arkwright in 1768 and Crompton in 1779 invented spinning machines which were worked by water power. Cartwright in 1785 invented a loom which was driven by water power.

Just before this time James Watt invented a steam-engine which pumped water out of mines. When he was but a lad he had sat watching the steam lift the lid of the kettle and push out of the spout. It suddenly occurred to him that the energy of the steam might be used to do something, and from that time forward he made experiments in his spare time. At last his experiments were crowned with success when he went into partnership with Boulton, who owned large works, and who had skilful workmen to make the engines as designed by Watt.

Watt's engine had nothing to do with spinning and weaving, but very soon others used the



By courtesy of Victoria Museum

FIG. 135

The Industrious Apprentice

This is one of a series of twelve engravings by Hogarth, entitled "Industry and Idleness." Hogarth had himself been apprenticed to an engraver. Apprenticeship probably arose in the Middle Ages. At that time a boy was termed an apprentice (learner) whether he was to be engaged in a trade or in a learned profession. The usual term of apprenticeship was seven years, this allowing time for the youth to receive adequate instruction, and also to pay his master for this by his services. He then became a master or a journeyman, and a member of the guild or corporation. Before the establishment of big factories which followed the Industrial Revolution, apprentices very often lived with their master while serving their terms.

principle of his machine and devised spinning and weaving machines driven by steam.

FIG. 136
James Watt

The result of all these inventions was that spinning and weaving were no longer done in the cottages of the people but in factories where many machines of the same kind were set up. At first these factories were set up beside the banks of swiftly flowing streams, so that the running water might turn the machinery, but after Watt invented his steam-engine factories grew up on the coalfields, so that the coal necessary for making the steam need not be transported about the country.

The cotton industry grew up on the Lancashire coalfield because of the soft water available, because the damp climate made the cotton threads less liable to break as they were being spun, and because of its position on the side of England which faces America (then the source of most of the raw cotton) with a splendid port in Liverpool. The woollen industry, which had been scattered all over the country but was specially important in Norfolk and Yorkshire and the Cotswold villages, now became largely concentrated in Yorkshire because there is no coal in Norfolk and the Cotswolds.

FIG. 137
Talbot Inn, Southwark, in the Eighteenth Century

FIG. 138
Arkwright, Inventor of Water-power Spinning Machine (1768)

FIG. 139
Cartwright, Inventor of Water-power Loom (1785)

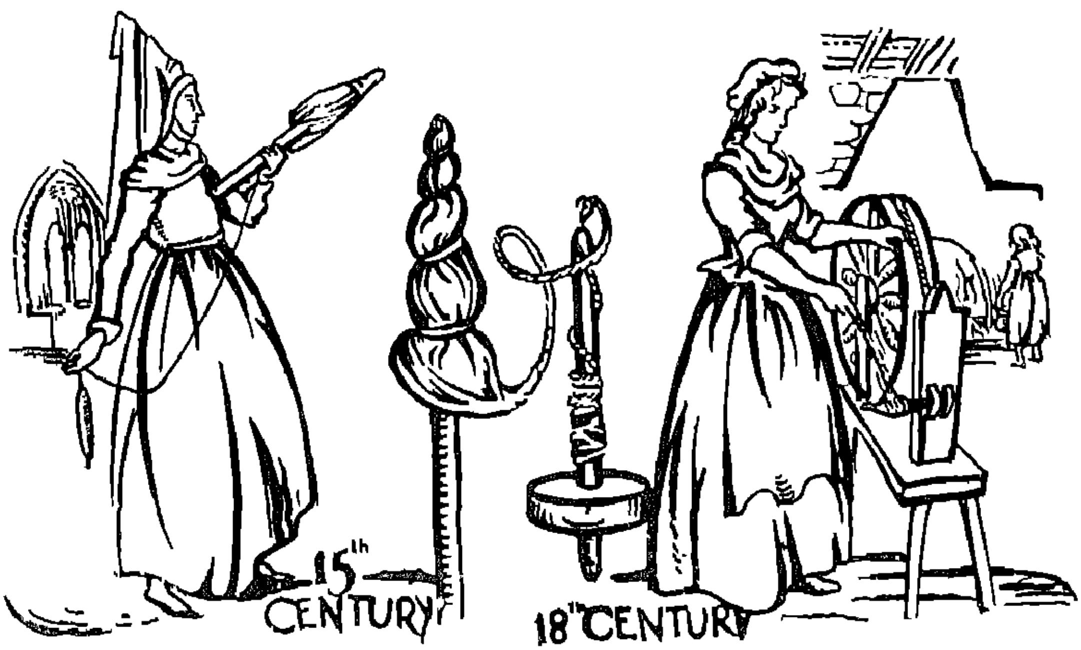
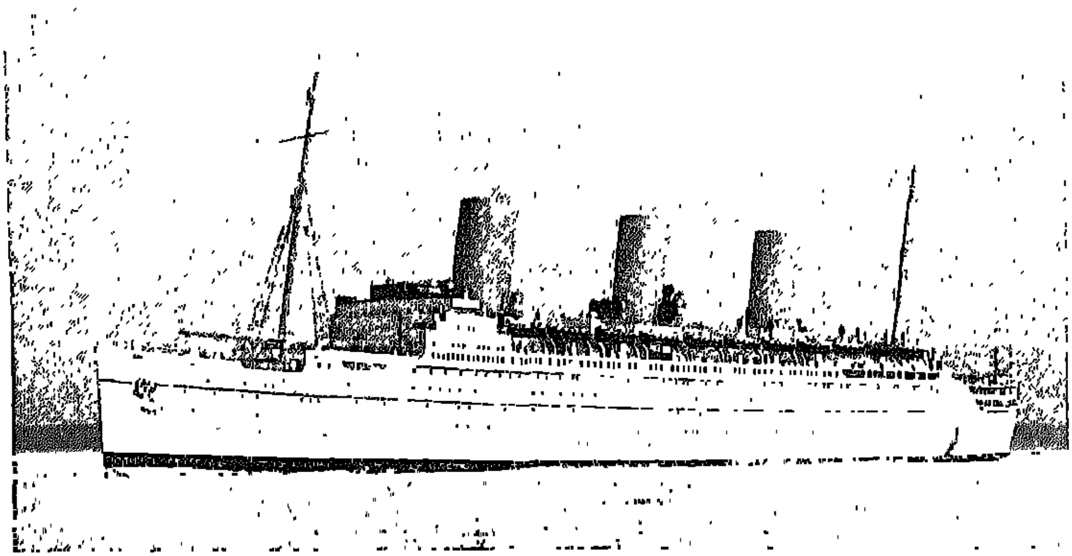


FIG. 140
Spinning



By courtesy of *The Canadian Pacific Railway*

FIG. 141

The Empress of Britain

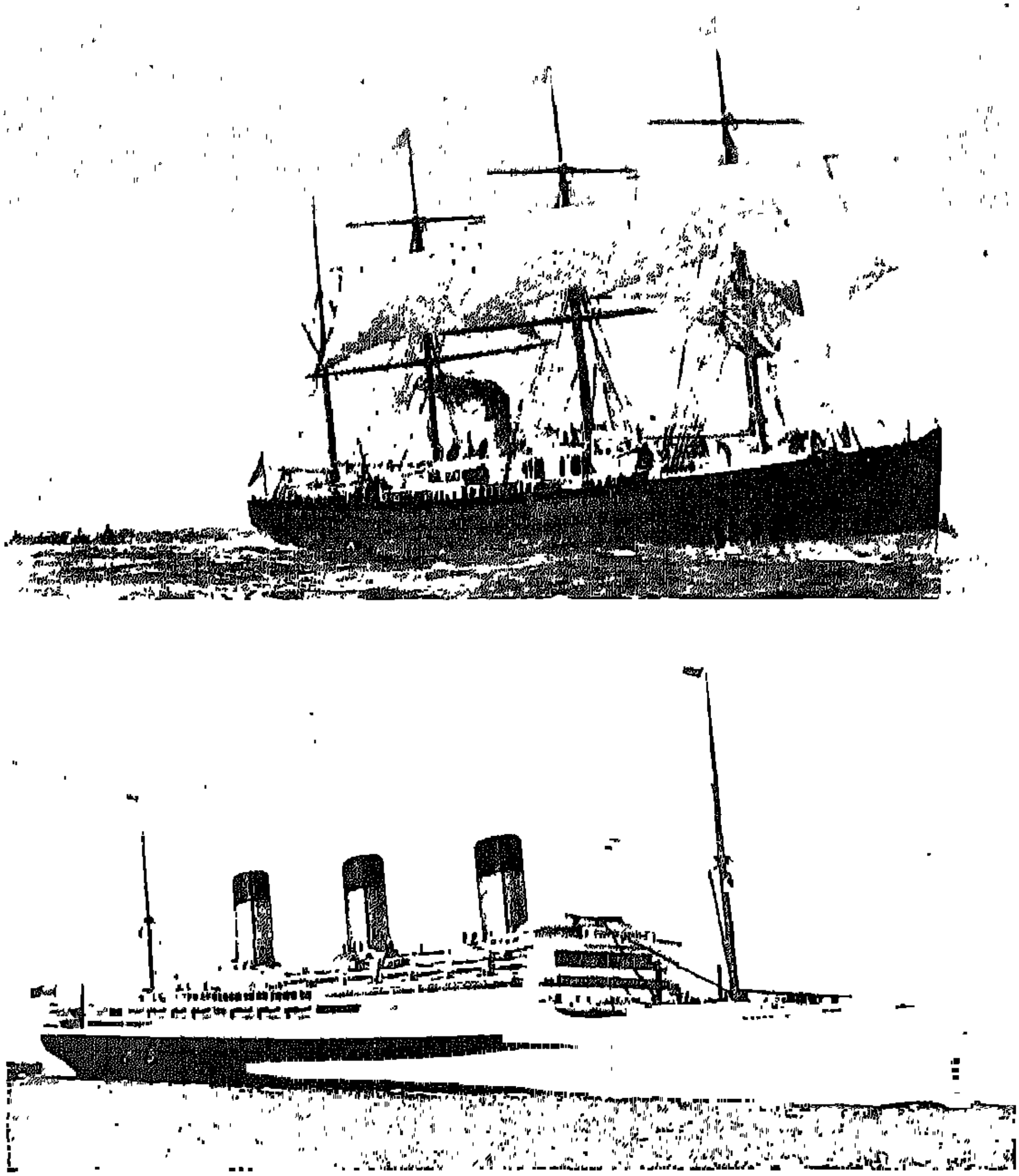
This oil-burning steamship, a modern luxury liner torpedoed by the Germans in 1940, made, in 1932, her record trip from Cherbourg to Father Point, Quebec, in 4 days, 7 hours, 58 minutes. The "blue riband of the Atlantic" is held by the British liner Cunard R.M.S. Queen Mary, for her record in making the standard Bishop's Rock–Ambrose Channel (off New York) crossing, which is 500 miles longer than the Cherbourg-Quebec journey, in 3 days, 21 hours, 48 minutes

[illegible]

FIG. 142

The R.M.S. Queen Elizabeth, 83,673 tons, the World's Largest Liner

This type of ship is driven by steam turbines operating four propellers. Oil fuel is used. Notice there are only two funnels.



By courtesy of The White Star Line

FIG. 143

Industrial Progress Typified in Steamships

Oceanic I, pioneer of the White Star Line, in 1869. 3,807 tons. Surprisingly fast Atlantic crossings were sometimes made with the help of favourable winds. Coal fuel was used.

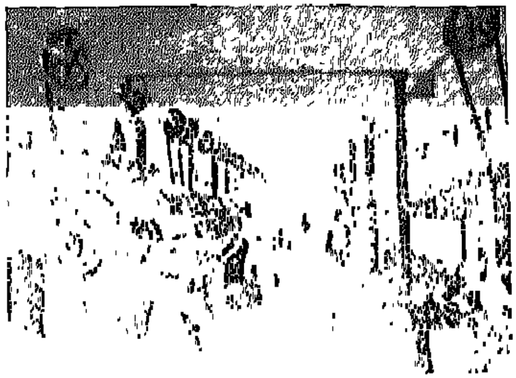
Majestic, the world's biggest liner in 1931. 56,621 tons. Fastest Atlantic crossing 5 days, 5 hr. 21 min. Oil fuel is used to heat the boilers.

Men and women left the country to flock to work in the new factories, and thus new large towns grew up round the factories.

Very many more goods were made by these new machines than had previously been manufactured by hand. Before they could be sold

Photographs by

FIG. 144
An Early Spinning Shed



R. B. Fleming

FIG. 145
An Early Weaving Shed

they had to be distributed through the country. In 1750 the only means of transport were in panniers or carts by road, by river, or by sailing ship.

First the roads, which had been very bad, were improved by Macadam. Then Brindley made canals, planning them as he lay in bed not with pencil and paper but in his head. The most famous of the canals which he made was the Bridgewater Canal, which was so useful that coal from the Worsley pits was sold at Manchester at 4d. a hundredweight instead of at 1s. as formerly. The canal was later extended to Runcorn.

Canals, however, provided but a slow means of transport for goods. It was left for George Stephenson to utilize the principle of Watt's engine to make a locomotive. The first railway line was that between Stockton and Darlington (1825), and by 1830 the Liverpool to Manchester line was completed, Stephenson's engine "The Rocket" winning a £500 prize by defeating its two competitors. At first thirty miles an hour was considered to be a very quick rate for a train to travel.

Reference should be made to the enormous growth of railways, and pictures of modern engines should be shown. Collecting engine numbers is still popular and gives a ready point of contact. The importance of goods traffic must not be overlooked. Older Juniors may be able to understand the significance of "British Railways."

Another use to which steam was put was to propel steam boats. As early as 1812 Henry Bell launched his steam boat *The Comet* on the Clyde. In 1819 the first ship fitted with a steam engine crossed the Atlantic, but the sails with which it was also provided proved more useful than the engine. In 1838 for the first time two ships crossed the Atlantic relying entirely on steam. They took respectively eighteen and fourteen days instead of the twenty-eight days required by a sailing ship. Nowadays the fastest steamers, such as the *Queen Mary* and the *Queen Elizabeth*, can cross the Atlantic in less than four days.

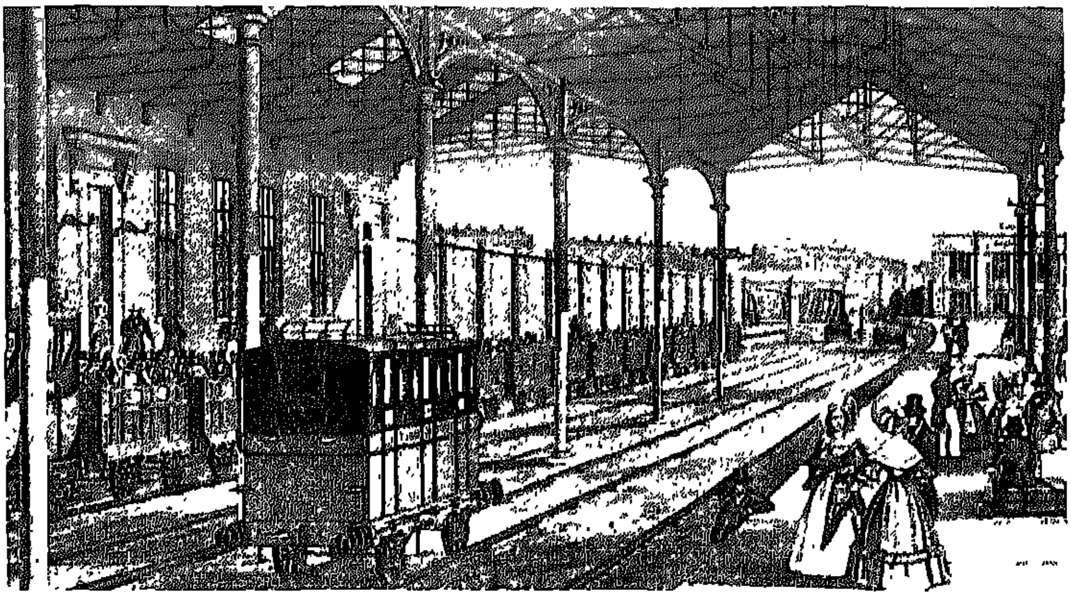
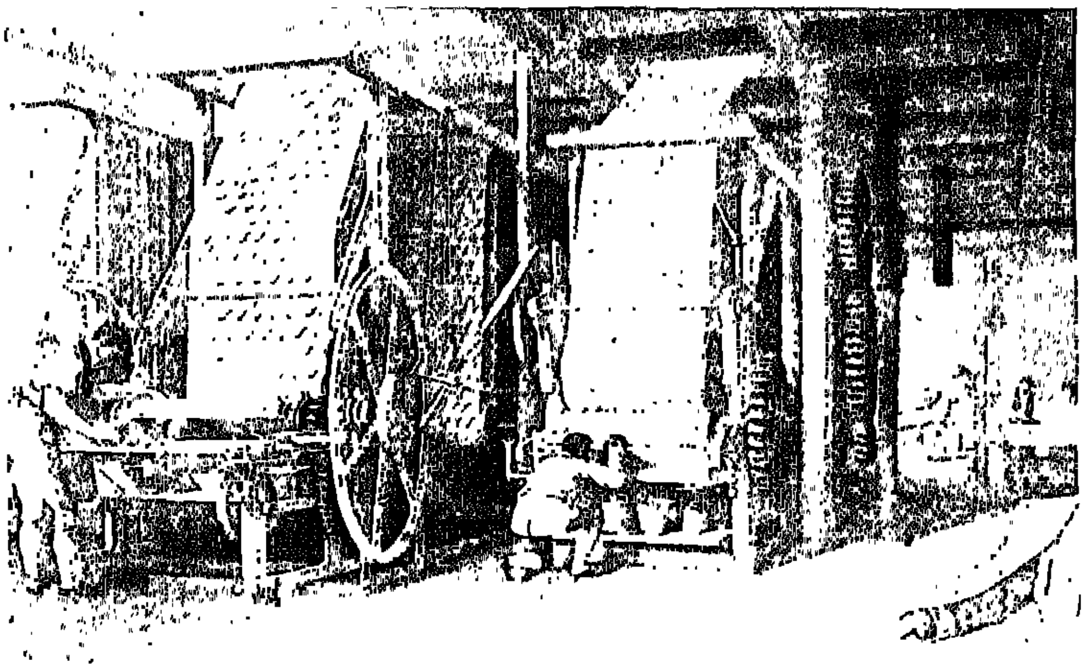


FIG. 146
Euston Station in the 19th Century



Photographs by — *[illegible]*

FIG. 147
An Early Calico Printing Factory

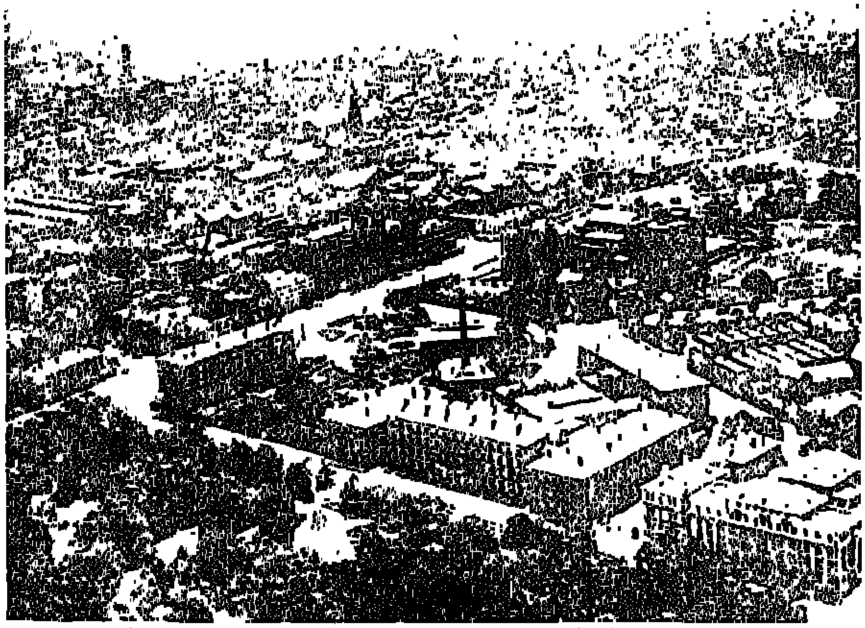
THE EXPLORERS OF AUSTRALIA

It was not till the beginning of the seventeenth century that Australia was discovered. Dutch seamen touched the coast at many points. In the eighteenth century Captain Cook, an Englishman, explored the coast and proclaimed that it was British territory (1768-1771).

On his return he read a paper to a learned Society about his voyages, and spoke favourably about Australia. When a little later it was no longer possible to send convicts to America because the United States of America had become independent of Britain, the English resolved to send convicts to the newly discovered continent. In the eighteenth century men were convicted for much smaller crimes than they are nowadays. If a man were caught stealing a sheep he might be hanged. Many of these convicts, then, were not thoroughly bad men.

In 1789 some seven hundred of them landed after a voyage of eight months at Botany Bay, on the eastern coast of Australia, under the charge of Captain Philip. He quickly found that Botany Bay was an unsuitable spot for a colony since the soil was swampy and poor, and there was no fresh water at hand, so he transferred his settlers to Port Jackson, later known as Sydney, where, as he could see, the whole of the British navy might securely lie at anchor.

Seven years later a man named McArthur saw that the grassy downs of the region and the dry climate were excellent for sheep farming. It chanced that two men were just leaving for the Cape of Good Hope. McArthur told them to bring him back a flock of sheep. Now it happened that six years previously the King of Spain had given to the Dutch government at the Cape some merino sheep The two men were able to buy some of these for McArthur, who with them founded the great sheep industry of Australia.



By courtesy of *The High Commissioner for Australia*

FIG. 148

Melbourne from the Air, Showing Victoria Government Offices in Foreground

McArthur wanted more of these sheep, and he knew that King George III of England had

some on his model farm at Windsor. At McArthur's request the King gave him some more merino sheep

For twenty-five years the Blue Mountains which stretch from north to south some 50 miles behind Sydney seemed impassable. In 1813, however, there was a severe drought, and three men, led by Blaxland, cut their way through the bush, scaled the cliffs, dislodged rocks, looking for some way to get through the mountains. At last, when they were almost giving up in des-

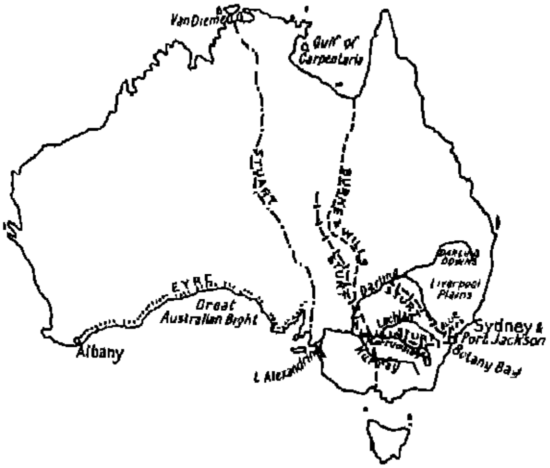


FIG. 149

Map of Regions of Australia Explored by 1862

pair, they found a pass 20 ft. wide between two precipices, which led them into a beautiful, well-watered valley. They called this the Vale of Clwyd, after a fertile valley in North Wales. On their return they blazed or notched the trees so that they might find again this new route that they had discovered.

Within the next two years the Liverpool Plains beyond the Vale of Clwyd were discovered. These plains were obviously suitable for the rearing of sheep. A road was then cut over the pass to the Liverpool Plains by a gang of convicts. It was a triumph of engineering, for in some places great chasms had to be bridged, in others solid rocks moved out of the way, and everywhere the ground had to be levelled. The town of Bathurst was founded. Within a year or two another route to the sea to the north of the Liverpool Downs was found.

Before the discovery of the Liverpool Plains the prevailing idea was that Australia was a vast desert ringed round with the small strip of territory suitable for men to dwell in This idea was now proved to be false, and the early Australian "Squatters" left the regions near the coast and, driving their flocks before them and carrying all their goods, settled or "squatted" as they liked in the newly discovered country. They followed the courses of the rivers, which were slow muddy streams because they flowed in a flat land.

In 1827 Allan Cunningham, breasting the Liverpool Range, came upon the Darling Downs, an unrivalled pasture of 6,000 square miles in an unbroken stretch. This was quickly peopled with squatters.

One of the greatest of Australian explorers was Captain Sturt. First he followed the course of what was later known as the Darling River. He and his men suffered from a particularly dry season. Suddenly they saw a river some 80 yd wide. They rushed to drink, but found that the water was salt. They wondered whether it was not a river, but an inlet of the sea. Then they found that it was a river, and that the saltness was caused by brine springs in its bed.

Next Captain Sturt set out to follow the course of the Murrumbidgee River, to discover whether it flowed into a lake or into the sea. After he and his companions had followed it for a week he realized that he could not take all with him. He therefore sent most of the men back, and took six with him in a little boat with provisions on a raft. The current of the river was very swift. The raft dashed into a rock and all the provisions were lost. Sturt, however, went on. They came to the junction with the Lachlan River, and after four more days to the junction with the broad river which they named the Murray, the greatest river of Australia.

For a month they travelled along the Murray River. At one place hundreds of natives threatened them from the shore. At last the river ended in a swampy lake they named the Alexandrina, instead of in a fine harbour as they had expected There was nothing for it but to return by the way that they had come For two months they rowed up stream, worn out by their exertions, hungry from lack of food,

and perpetually in danger from the natives. When they reached the spot at which they had separated from the rest of their party a rescue party found them, bringing them food, and together they returned happily to Sydney, Sturt's party having travelled over 2,000 miles.

Later, in 1844, Sturt set off northward from a point near the junction of the Lachlan and Murrumbidgee Rivers. He finally reached a very parched region where it was so hot that he and his companions had to dig a cave for themselves. The ink dried on their pens before they could write, the screws fell out of their boxes, the lead fell out of their pencils. At last they had to return, having journeyed as far north as Coopers' Creek.

Another of the heroic explorers of Australia was Eyre, who in 1841 made a journey beside the coast of the Great Australian Bight from Spencer Gulf to Albany across country that had never been traversed before. He took with him one white companion and three natives. They carried some water with them on the horses' backs. For 135 miles they found no water, and then they found it by digging 5 ft. Not till they had traversed another 160 miles did they find water again. Another time they were saved from dying of thirst because Eyre collected some water on a sponge. The next misfortune was that two of the natives shot Eyre's white companion and made off with the ammunition.

Eyre went on with a faithful black boy. They were almost at the end of their supplies when a French whaling ship came into the bay. The captain gave Eyre and his little black boy sufficient supplies for the rest of the journey to Albany, which took about another month. Along the route traversed by Eyre now runs a railway connecting Albany with Adelaide.

The first explorers to cross the Continent from south to north were Burke and Wills in 1862. Their return journey from the Gulf of Carpentaria was terrible, for they suffered first from heat and thirst and then from the rainy season. They both lost their lives in the attempt, but one of their companions reached safety.

McDouall Stuart tried to cross from south to north. At the third attempt he succeeded in reaching Van Diemen's Gulf because he found a well-watered strip of country. The route he followed is covered to-day by the trans-continental telegraph connecting Adelaide with London.

(*For pictures of Australia see Vol II, Wool Chart, and pp 527–9, 551, and 555, also p 815*)

JOHN LAWRENCE

John Lawrence was born at Richmond in Yorkshire in 1811. His father had been a soldier in India, and both he and John's mother were Irish. John went to a day school in Bristol, where he was flogged every day, and on account of his Irish name the boys nicknamed him Paddy and kicked him Then he went to a school in Londonderry, where he was kicked as English under the name of English John Finally he went to Haileybury, the College which had been founded by the East India Company for the training of their future servants. His three older brothers were already in the Indian army, but at the conclusion of his school career Lawrence went into the Indian Civil Service.

First of all he worked at Delhi, acting as Judge and collecting taxes. From there he was transferred to control a district with Panipat as its headquarters. The people there were rough and warlike, but Lawrence quickly won their hearts. When he went out with his gun he talked to every one he met, and his house was open to all callers, rich and poor. In this way he got to know what was really happening, and what all kinds of people thought. He was always on the spot when anything of importance happened. If a man had done wrong he was much afraid of Lawrence's anger.

In the evenings he used to sit out in the garden in the moonlight, and the Indians used to drop in to see him. They talked over all the events of the day, and then at midnight they got up quietly and left him.

One walled village would not pay the land tax. The usual custom in such circumstances was for the collector to use force. Lawrence surrounded it with police, and blocked the way to the cattle pastures. At daybreak the animals

FIG. 150

Hindu Girl returning from the Ghat

The Ghat is the landing stage and steps leading down to the river

came out, but they were driven back, and the cowherds told that the cattle would not be allowed out till the tax was paid. Again and again they tried to drive the cattle out, but without success. Then they said that they had not the money to pay. Finally, at about 3 o'clock the money was produced, and the cattle rushed out to their pastures.

Lawrence held various positions in India until he fell ill and had to go home for three years' leave (1840). After his return the most important post he held was that of Governor of the Punjab, a province new to the British Empire. First of all he completely disbanded the Sikh army, which had recently been fighting against the British. These men, who had been peasant proprietors, quickly took up their old life of agriculture. The rest of the people were disarmed, and the province was at peace.

Next he set to work to make roads and bridges which would prove useful to our soldiers, and would also provide highways for trade. New canals were cut to irrigate the land, so that the Sikhs were more prosperous than ever before. A code of laws was drawn up which was both just and simple, and taxation of the new province was settled in such a way that it was lighter than ever before. All this he did in the same friendly way as he had collected taxes in Panipat. He trained the officials under him in his ways, and the result of his government was that the Punjab became the model province in India, and English and Indians were alike devoted to Lawrence.

Then came the Indian Mutiny, not in the Punjab but in the rest of Northern India under British control. The Indians were alarmed at the numerous improvements brought in by the British, the "fire carriages," as they called the trains, and the "lightning posts," as they called the telegraph posts.

The Mutiny occurred among the *sepoys*, the native troops in the Bengal army. The new Enfield rifle had been served to them, the cartridges for which were greased with cows' fat and pigs' lard. The ends of the cartridges had to be bitten off by the sepoys before they could be slipped home. As the Hindu regarded the cow as sacred, and the Mohammedan thought that the pig was unclean, the sepoys believed that the serving of these rifles and cartridges was an attempt to undermine their religions. The Hindus were afraid of losing caste, and for the same reason they feared travelling by train because they might have to sit in the same carriage as a man of lower caste.

The Mutiny broke out near Delhi, and the sepoys marched to that city, the ancient capital of India, and proclaimed an Indian prince as Emperor of India. Sepoys in Cawnpore and Lucknow were in revolt too, but the centre of the rebellion was at Delhi.

In this crisis John Lawrence gathered together an army in the Punjab, which remained loyal to the British government, and sent it to Delhi. After a long siege these troops, under John Nicholson, captured the city. Thus the good work which Lawrence had done in the Punjab was of incalculable value in the hour of danger, when it seemed as though the English, through the Mutiny, might have to leave India.

At Lucknow, another centre of the rebellion, Sir Henry Lawrence, John's brother, rallied a splendid body of sepoys to the defence, and they stood a five months' siege until they were relieved by Henry Havelock, but by this time Sir Henry Lawrence was killed. After this Havelock and his men were again besieged in Lucknow, and it was not till two months later that Lucknow was finally relieved by Sir Colin Campbell.

This ended the Mutiny. When it was over the government of India was transferred from the East India Company to the Crown. Queen Victoria was proclaimed Empress of India, and "Ind. Imp." was for many years added to the inscription on our coins.

After the Mutiny Lawrence returned to England and was hailed as "The Saviour of India." He was knighted, and granted a pension for life

Five years later Sir John Lawrence returned to India as Viceroy, and for five years he acted as the representative of the Queen in India. In those five years he tried to do for the whole of the British territory in India what he had previously done in the Punjab. On his return, in gratitude for his services, he was created "Baron Lawrence of the Punjab."

A short reference will be made to recent changes and the present Indian and Pakistan Governments.

By courtesy of The India Office

FIG. 181

Lord Lawrence, with some of the Members of his Government

Lord Lawrence is seated on the extreme left of this picture.

THE YEOMEN OF THE GUARD

(See Frontispiece)

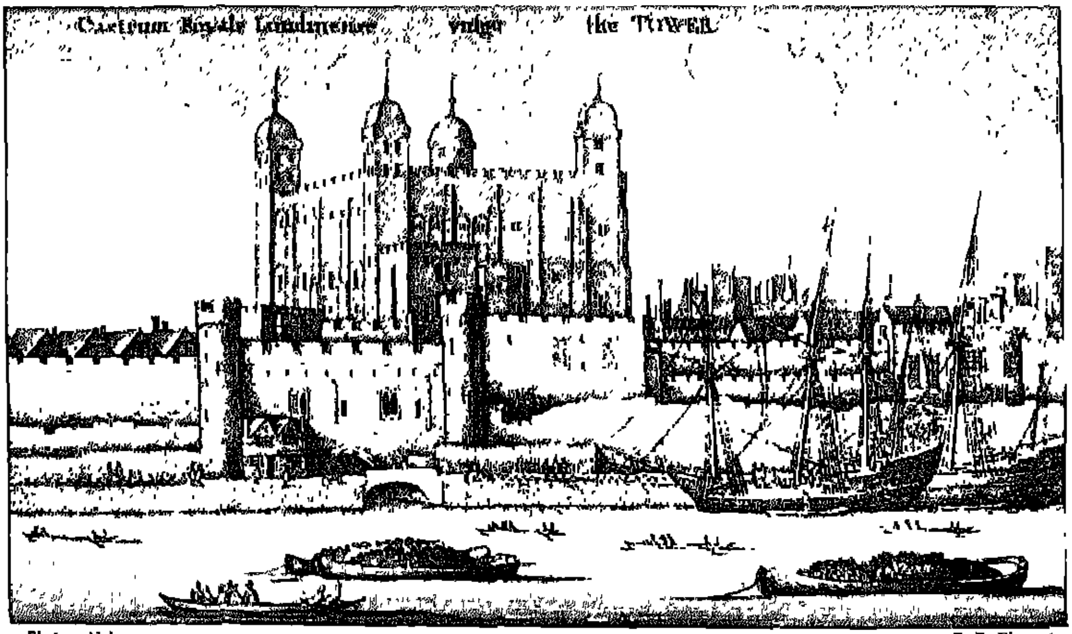
The Yeomen of the Guard were instituted by Henry VII, in 1485, to act as a royal body-guard both in the royal palaces and on his journeyings.

The dress which is worn by them to-day is almost the same as in Tudor times—a royal red tunic with purple facings and stripes and gold lace ornaments, red knee-breeches and red stockings, flat hat and black shoes with red, white, and blue rosettes; the ruff, however, was introduced by the Stuarts. Their present weapons are a steel gilt halberd with a tassel of red and gold and an ornamental sword.

The Yeomen of the Guard are chosen from among those who have distinguished themselves in the army or the marines, and their pay is looked upon as a pension. They take part in the reception of foreign potentates, levees, courts, and State banquets. They have a share in the search which, since the time of the Gunpowder Plot, has always been made in the Houses of Parliament before their opening, in the ceremony of the distribution of Maundy Money in Westminster Abbey, and in the Epiphany offerings of gold, frankincense, and myrrh in the Chapel Royal at St. James' Palace.

They may owe their nick-name, "Beef-eaters," to the Grand Duke of Tuscany, who in 1669 described them thus: "They are great eaters of beef—and they might be called 'Beef-eaters.'"

The Tower of London warders, who wear the same uniform with the exception of the cross belt are a body distinct from the Yeomen of the Guard. They were instituted in 1509 or 1510 when the young King Henry VIII left twelve warders at the Tower of London on giving it up as a permanent residence.

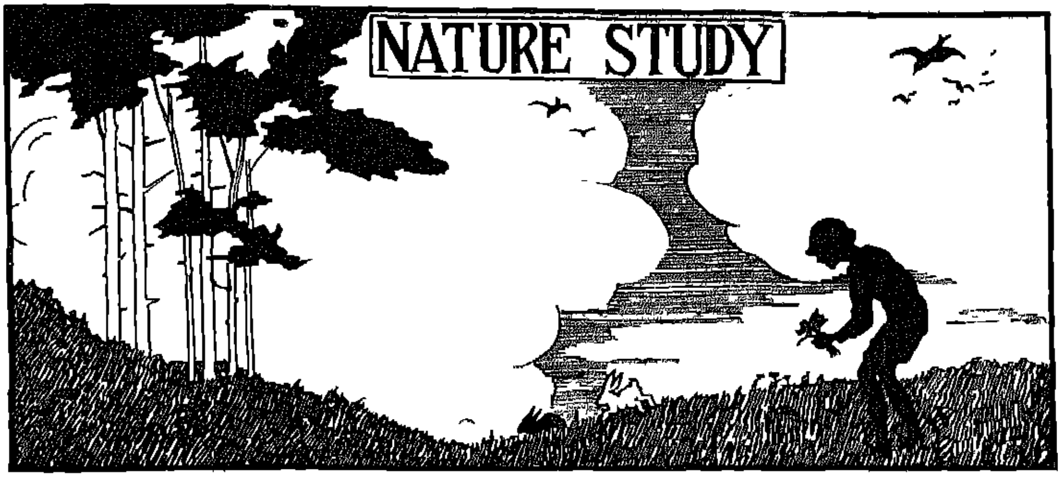


Photograph by R. B. Fleming

FIG. 152

The Tower of London

From an old print The building of the White Tower was begun by William the Conqueror



"Nature Study should form an integral part of the curriculum of every school . . . its cultural value cannot be denied" - REPORT ON THE PRIMARY SCHOOL, 1931

NATURE Study is one of the most important subjects included in the Junior School Curriculum. Properly taught it should train children in the power of observation and in the ability to express observations simply and accurately, and should stimulate interest in environment. Habits and interests cultivated in the earlier years of school life can bring pleasure and profit throughout life. Some of the greatest naturalists the world has known have commenced the study of the living things of Nature when quite young. The following statement should be remembered by all teachers—

> In Nature Study we aim at seeing, understanding, enjoying, and practically learning from the natural world round about us. It need hardly be said that Nature Study has gone wrong when it becomes bookish or too much of a lesson.—Professor SIR J. ARTHUR THOMSON.

It is most important for the teacher of Nature study to realize that the main part of the work done must be performed by ***individual*** children. Formal lessons may have to be given in order to explain principles and to impart information. The work must be a failure if it stops there. Keenness and interest must be so stimulated that the pupils are eager to perform experiments, make observations, and record the results of both. With this purpose in view, the work suggested in this course will give many ideas as to how the individual side of the work can be stressed, and the work made really practical.

For the convenience of the teacher the matter here is sectionized under the headings "Observational Work," "Plant Life," "Bird Life," "Insect Life," and "Animal Life." The course for Juniors should be arranged to include lessons from each of these, in order that as great variety as possible may stimulate the interest of these young children. This does not mean a lack of coherence in the scheme, for lessons on the weather will lead up quite naturally to discussion of the seasonal changes, which in turn introduce (according to the season) the matters of germination, flowering, or fruits; after a few lessons on flowers some details of the insects which pollinate them will naturally follow, while, after the lessons on fruits, the functions of animals and birds as seed distributors may serve as a link with lessons dealing with the carnivorous animals.

The study of Nature may be likened to the fitting together of a jig-saw puzzle or of links in a chain; the teacher's function is to open the child's eyes to the significance of things observed, and point out their relationship to one another. Thus some teachers may prefer to work out their schemes in groups of lessons covering the same aspect of plant, bird, insect, and animal life, as, for instance, the period of *growth* of tiny plants, birds, insects, and animals, including the effects of the weather, common need of air, water, etc., or again, a series of lessons on the part played by *colour* throughout the kingdom of Nature (protective and attractive colourings, and use of green colour matter to plants).

Nature Study in Town and Country

The course of Nature Study which will be mapped out in this section deals with a wide variety of subjects. It may be interesting to show how the course may be used in both town and country schools.

Then it is possible to plan Nature rambles at various times of the year. Seasonal changes are very easily noticed if the same walk is taken in all four seasons. Such a ramble should include, where possible, a walk through a field, a wood, along a water course, and through allotments.

FIG. I

Cowden Young Farmers' Club: The Vegetable Plot

Country Schools

In the country there will be little difficulty. A plentiful supply of specimens can be obtained quite easily by both the children and the teacher. It is also possible, in many cases, for a garden plot to be provided, where plants can be grown and studied in their natural environment. Seeds can be sown to give the flowers needed for study, and vegetables can be cultivated. Even where this is not possible the interest of parents and gardeners can be secured, and the necessary arrangements can be made for a supply of materials.

Pets can be more easily kept in the country. Children can find more space for rabbit hutches and fowl pens than would ever be available in the town.

Further, the environment of the country born and bred child is that of Nature. Anything which will stimulate a love of the country and teach appreciation of quietude and beauty must be included in the syllabus of a country school. The surroundings of home and village will be more pleasant where a love of Nature has been inculcated. The art of the teacher must be used to create a love for Nature study, to make it

real and purposeful, and not a lesson in which facts are hammered into unwilling heads.

Town Schools

The town teacher, who has to take up the teaching of Nature Study, and who has read the foregoing paragraphs, may think that a case for Nature Study in the country has been proved, but that this study cannot be recommended in the town. Further considerations, however, will show that the case is almost equally as strong for including it in the curriculum for town schools.

In the midst of large groups of buildings, where few green things can be seen growing, and where the mechanical inventions of man seem to rule, is just the place to add balance to the conception of life by interesting children in living things. The very silence, persistence, and perfection of growth teach important lessons.

FIG. 2
Cowden Young Farmers' Club: The Rabbitry

Beauty is often misinterpreted in the city. Children are apt to think that powerful electric lights, highly coloured posters, and artificial colouring typify beauty. That this is not always so, however, is seen in the passionate zeal with which some children, and adults too, tend a small plant, admire a bunch of flowers, or care for a pet.

There are few difficulties in the way of arranging real Nature study lessons. An analysis of the headings of this section will show how true this is.

Weather observations can be made in every town. Points of sunset and sunrise may not be indicated on the horizon, but directions can be taken and related to buildings. Even cloud forms can be noted.

Germination. Every experiment under this heading can be carried out in a town school.

Bulbs and corms can be grown in bowls, pots, and glasses, and the gaiety of the school will be increased in spring time.

Seasonal changes are more difficult to observe. Where a park is within easy distance of the school much useful work can be done. The trees can be watched and their changes noted. Operations in the flower beds of the park do in some measure parallel those of the garden. Incidentally, the park gardener is often a good friend to a teacher requiring Nature specimens.

Plant growth can be observed by sowing seeds in large flower pots or in window boxes. Broad and kidney beans, peas, nasturtiums, and many other kinds of plants can be cultivated and the experiment on the rate of growth can be done.

The greengrocer's shop can supply brussels sprouts and cos lettuce for the study of buds.

A timber yard can be visited in order to get the section of a tree and a piece of board showing sap and heart wood and the presence of knots.

Leaf and flower study may be a little more difficult. Leaves must be obtained from a park, from various gardens, or by a week-end visit to the country. Flowers are much easier to procure, and although the varieties of flowers to be purchased in the town are fewer than those that can be picked in the country, yet a supply of typical flowers can be obtained at all seasons. Similarly typical fruits can be purchased. A real difficulty may be experienced in obtaining sufficient twigs of several varieties of trees in order to study terminal buds, leaf scars, etc. The teacher may be able to obtain some by taking a bus ride at the week-end. Similarly some of the class may be able to help. Some teachers write to friends in the country and get supplies that way. If only one example can be obtained the work can be taken by the teacher.

Birds. The study of birds in a town is certainly a difficulty Yet, after consideration, there is much that can be observed. The habits of starlings and sparrows can be studied. Chaffinch, tits, robins, and many other birds frequent the yards and gardens even in town, especially in winter. The teacher can describe the life and habits of some of the more common birds. Flocks of birds preparing for migration are often seen in towns. Swallows, martins, and swifts are there too.

Insects. It will probably be necessary to give lessons on bees. The fly is, however, a typical insect which abounds in towns. The life history of an insect can be studied by rearing silkworms from the egg stage. Ants and beetles can be seen. Crickets are sometimes caught and the mosquito larva may be found in a rain-water butt. Moths can be caught after dark with the aid of a lantern, and even in cities the furs of ladies are often destroyed by the larvae of the destructive moth that lays its eggs amongst clothes.

Animal Life. Lessons on common pets can be given. A visit to the Zoo may be possible. A tank or bowl of fish can be kept. The proprietor of a naturalist's shop will be found generally to be a good friend to a teacher of Nature study.

Has the case for the possibilities for Nature study in the town been made out? Of course, all that has been said presupposes a keen interest in the teacher responsible for the subject. Where this exists and the teacher gets real pleasure from the study of growth of flowers, and of the living things of the world, then the town child as well as the country child will become an enthusiast.

Illustrations

The Nature Plates in this volume, and the subjects in the PRACTICAL JUNIOR TEACHER coloured Nature Study Chart, are reproduced by courtesy of the Trustees of the British Museum (Natural History). These and many other subjects may be obtained as post cards from the British Museum, and on page 728 are given particulars of cards especially useful in the Junior School.

FIG. 3

Wild Flowers of the Meadow

(1) *Buttercup*, (2) *Yellow Rattle*, (3) *Milkmaid, or Lady's Smock*, (4) *Blue Bugle*

Animals.

B11 African Lion B17 Great Panda. B16 Maned Wolf. B12 Tiger. B13 Clouded Leopard. B132 Grizzly Bear. B19 Walrus B130 Polar Bear. B45 Kangaroo.

British Mammals.

B63 Badger. B64 Fox B65 Otter.
All the above are monochrome and 2d. each

British Dogs.

Set B9 5 monochrome cards at 2d. each.

Birds.

Most of the British birds are illustrated in colours

Set C1. British Birds 10 monochrome cards, 1s. 6d.

Set C14. Summer visitors. A set of 5, 1s. 6d
,, C15 and 16. Residents. Two sets of 5, 1s. 6d. each.

Birds Eggs—Set C7. A sets of 5 coloured cards and leaflet, 1s. 6d.

Set E1. Representative British insects—10 monochrome, 1s. 6d.

British Butterflies—Series 1, Set E5, 5 for 1s. 6d. coloured.

British Moths—Series 1, Set E7, 5 coloured cards, 4d each.

British Butterflies—Set E20, 3 cards, 4d. each.

Life history of British Butterflies, Set E51, 5 coloured cards, 4d. each.

Shows each stage of metamorphosis.

British Flowering Plants.

Cards 2d. each, coloured.

F73 Sea Pink. F39 Mistletoe. F41 Gorse. F46 Hawthorn. F59 Harebell F52 Wood Violet.

British Trees.

Set F25. 4 cards 6d.—Beech.
,, F35. 4 ,, 6d.—Oak.

Frogs and Toads.

Set K1. 5 for 1s. 6d. coloured

Reptiles

Set K2. 5 for 9d. monochrome.

British Spiders.

Set N2. Coloured, 5 for 1s 6d.

Nature Study Plates.

PLATE I.	F53.	White Bryony.
	F54.	Primrose.
	F68.	Tufted Vetch.
PLATE II.	F131	Ash
	F144.	Horse Chestnut
	F135.	Beech.
PLATE III	C82	Martin.
	C93.	Starling
	C94.	Chaffinch.
PLATE IV.	E117.	Clouded Yellow Butterflies
	E283.	Purple Emperor Butterfly.
	E287.	Jersey Tiger Moth.

Nature Study Chart.

E271	Swallow-Tail Butterfly.
E229.	Carpenter Bees.
C92	Blackbird.
C81.	Cuckoo.
E228.	Wasps.
E279	Puss Moths.
C88.	House-sparrow.
C87.	Robin Redbreast.
C89	British Great Titmouse
F65.	Cuckoo Pint.
F86.	Creeping Buttercup.
C51.	Birds' Eggs.
C52.	Birds' Eggs
F52.	Wood Violet.
F31	Common Poppy.

A discount of 25 per cent is allowed to Educational Authorities and Institutions on any purchase, direct from the Museum, of the above cards to the value of £1 and upward.

Full list of cards is given in Leaflet N.H.M. Form 170. Write to The Director, British Museum (Nat. Hist.), Cromwell Road, London, S.W.7.

OBSERVATIONAL WORK

WEATHER CONDITIONS

Weather Charts

THE simplest kind of weather chart suitable for the first year in the Junior School will be one showing the daily weather by simple drawings. The diagram will show how the monthly record sheet is prepared from a large sheet of cardboard or drawing paper, 30 in. × 20 in. The pupil appointed to keep the record inserts the sketch at a given time each day. It is better to make the sketch at the close of morning school rather than earlier in the session, as the general state of the weather can be judged better at the later hour. Sketches such as the following are easily made :--

1. Fine weather—a yellow sun with rays.
2. Mainly fine with a few showers—sun peeping from a cloud, and a closed umbrella.
3. Wet—an open umbrella.
4. Windy—a kite.
5. Snow—a snow man.

Other simple designs can be evolved by the teacher. Where possible each child should keep a daily record. Drawing paper or books divided into 1-in. squares (as used some years ago for brushwork) will be quite suitable.

From this elementary type of weather chart the children can proceed to more difficult forms, but they must first acquire more knowledge.

What is a Wind?

A wind is moving air—move a piece of cardboard about rapidly. What do the children notice? Let them fan themselves with a book and explain what they feel. To give some idea of the fact that air takes up space, push an inverted glass jam pot into a bowl of water. Ask why the water does not enter the jam pot. Lead the children to see that air must be a substance. Tilt the pot. Show them the escaping bubbles of air, and the entrance of water. Having established the fact that air takes up space and is matter, the next question that will arise is. What causes winds? Procure a paper balloon and *show that hot air rises.* A large paper bag inverted and pulled wide open when lit on the edge will move upward. Explain that thus the heat of the sun causes air to rise, and thus lead to the fact that air must come in to take the place of that which has so risen. This is as far as it is necessary to go in the first stage. Show the existences of draughts under a door and the upward movement of air over a fire --smoking rag or paper will be useful for this.

The weather-cock or *vane* shows which way the wind blows. Ask for examples of all weather-cocks in the district. Notice that all vanes have a vertical rod which can rotate on a pivot. On the rod is fixed a vertical plate or figure. This is attached to one side of the rod so that the wind blowing against its flat surface turns the figure until it gives the least resistance to the wind. The frequent use of the figure of a cock may be explained by the fact of its having been regarded as the emblem of vigilance.

The Cardinal Points

These must now be taught or revised. Remember, for guidance in the day time, that the sun rises in the east and sets in the west, and is in the south at noon. Obtain these facts from the children. Show how to recognize the pole star at night time, from the position of the group of stars known as The Great Bear. Facing the north, the east is on the right hand, the west on the left, and the south behind. Mark the four cardinal points on the classroom wall. Make a drawing on the blackboard, and teach the 4 points between the 4 chief ones -NE., NW., SE., SW.

A Wind Rose

The class is now ready to make a wind rose. Each child can make one in a drawing lesson. Eight lines, 3 in. long, to represent the chief cardinal points, are drawn from a central dot

WEATHER CHART

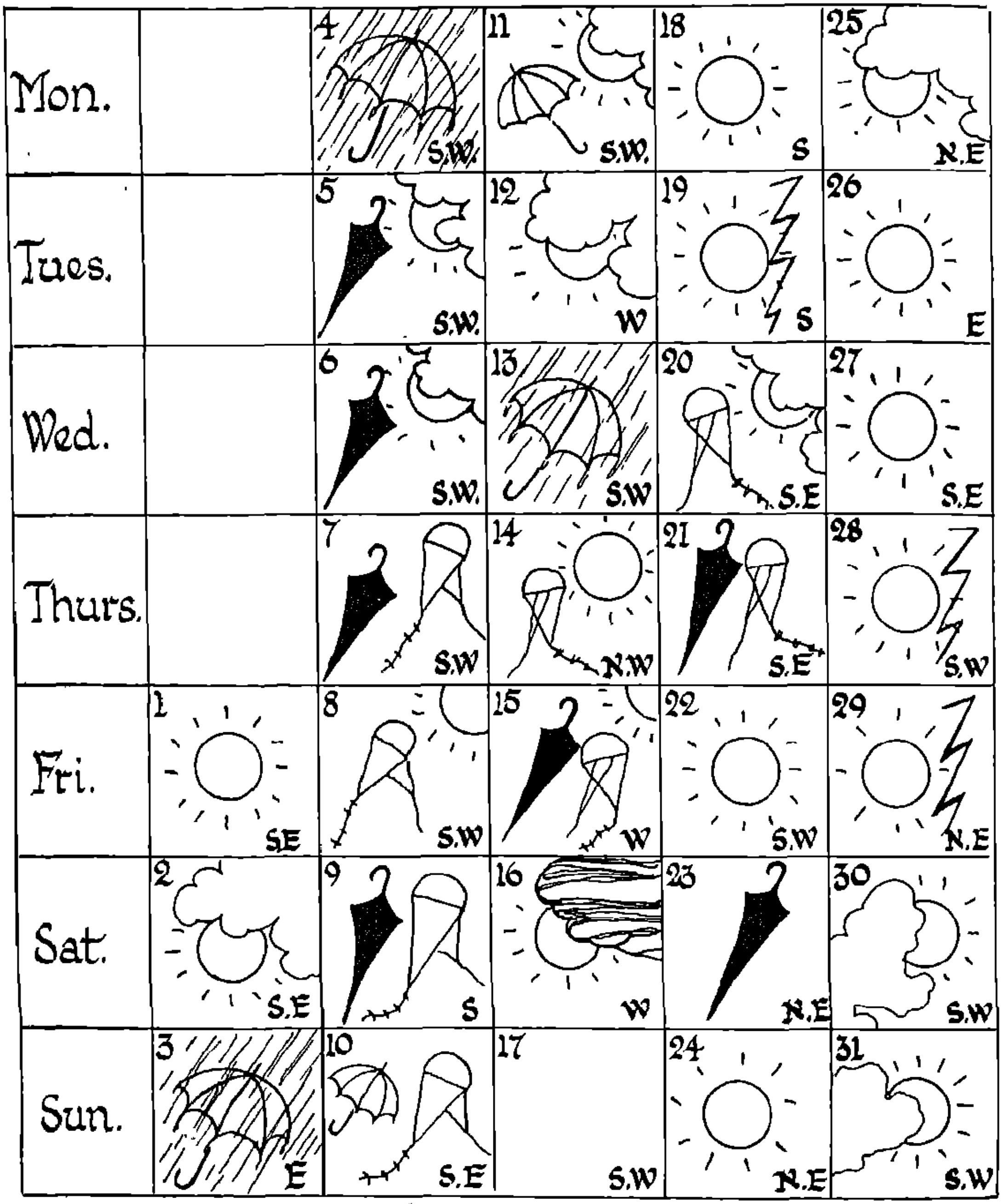


FIG. 4

The names of the cardinal points are written on the chart. The wind blowing in the morning is noted A distance of, for instance, a quarter of an inch is marked off on the appropriate line, and the date is written by the side. Notice that a wind is called by the name of the direction *from* which it blows: thus a south-west wind comes from the south-west and blows toward the north-east.

A more difficult form of wind rose may be kept in the third and fourth years of the Junior School. This type (Fig. 5) shows the weather.

Wind Force

In 1805 Rear-Admiral Sir Francis Beaufort, hydrographer to the British navy, when captain of the store-ship *Woolwich* invented a scale of numbers to represent the force of the wind. This table of numbers can be written up on a chart

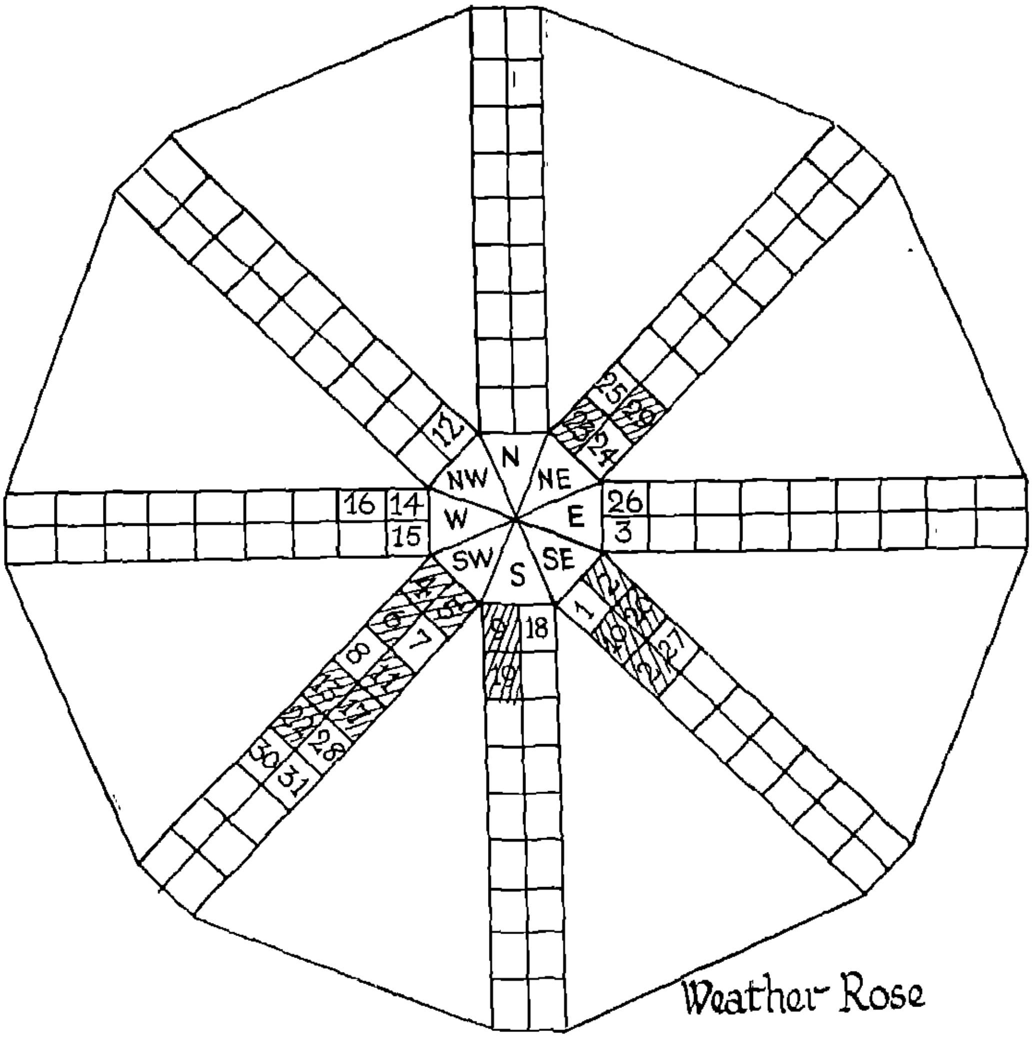


FIG 5

Rose as Made by Older Juniors

The number indicates the day of the month Rainy days are shaded.

in the classroom, and the older children in the Junior School can use them—

Beaufort No	Description of wind	Effect of wind on Land
0	Calm	Smoke rises straight up.
1	Light air	Smoke drifts in direction of wind.
2	Slight breeze	Wind can be felt on face. Leaves rustle
3	Gentle breeze	Leaves and twigs move—small flag lifted
4	Moderate wind	Small branches of trees move Raises the dust
5	Fresh wind	Wavelets on lakes—small trees sway when clothed with foliage
6	Strong wind	Tree branches move, telegraph wires "sing"
7	High wind	Trees sway
8	Gale	Twigs fall from trees.
9	Strong gale	Chimney pots and slates fall.
10	Whole gale	Trees torn up by roots.

It can be seen that daily observation of the wind on these lines is valuable.

Beaufort also suggested other symbols, and these can be used—

b—blue sky ($\frac{3}{4}$ at least blue).
bc— „ „ ($\frac{1}{2}$ blue)
c—cloudy ($\frac{3}{4}$ cloud at least)
o—overcast.
f—fog
m—mist
s—snow.
w—dew
x—hoar frost.
r—rain.

Rain

The top class of the Junior School should understand something of the rain gauge which is explained in the science section later. All children should know that 1 in. of rain means that if the earth were perfectly flat and waterproof then 1 in. of water would be deposited on the ground.

The rain gauge should be in charge of one of the staff and the children in the top class should take it in turns to read it. The results should be recorded in a book, and the teacher should make a small wall chart in each room and explain it daily. Comparison between the rainfalls of different months should be made, and the nature of the wind should be noted and recorded.

Temperature

Tell the children that when substances are heated they grow larger, but become smaller when cooled (mention might be made here of the spaces between railway lines). Show a thermometer and explain that the liquid in the stem gets larger when the weather or room is hotter, and so it rises. The marks on the side, called the *scale*, give us a number which is known as the temperature. Even the youngest

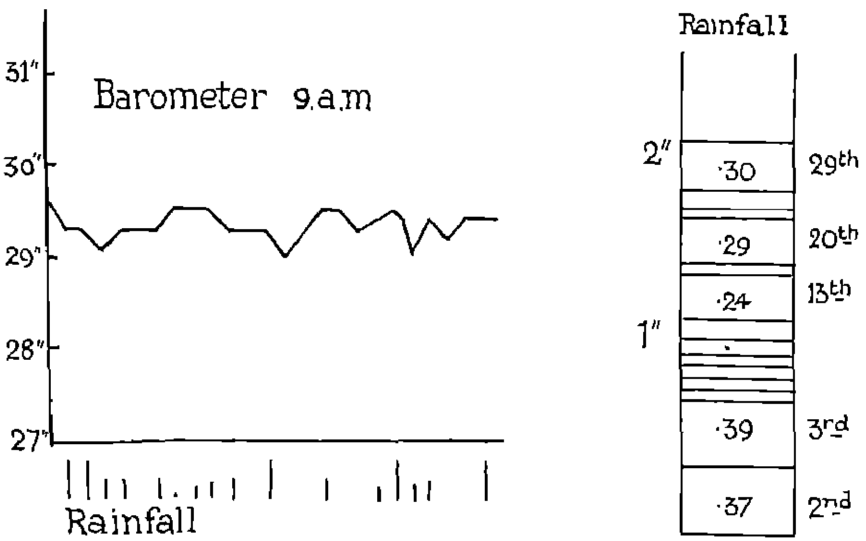


FIG. 6

Chart Showing Height of Barometer and Rainfall

children can *read* the thermometer daily and record the results. Older children can be taught more fully about the thermometer, and this piece of apparatus is described later, in the Science chapter.

Methods of graphically showing temperature on squared paper can be introduced in the top class of the Junior School

Altitude of the Sun

The children will know that the weather is generally hotter in the summer than in the

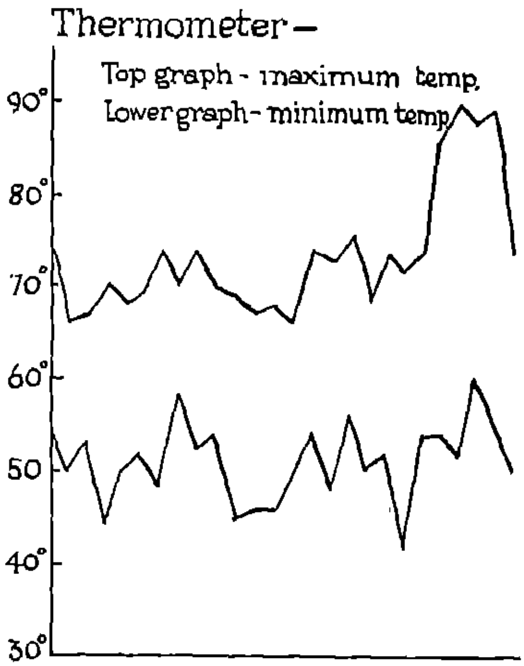


FIG. 7

Thermometer Charts to be made on Squared Paper

winter. Few will realize that this is due to the greater length of day and the higher altitude of sun at noon in the summer. Daily observations of the sun's height should be taken and recorded in *all* classes. The simplest piece of apparatus is made by fixing a yard stick in a wooden base. Obtain a piece of ½ in. *dowelling* from a hardware shop Bore a ½ in. hole in a square base board and fix the dowel into the hole. Set the stick up in the playground at the same time each morning, when the sun is shining, and measure the shadow. Record the length of the shadow on a chart.

Sunrise and *sunset* are rather difficult to observe, but the times of these are given in many pocket diaries. The exact direction of sunrise and sunset vary—on two days only does the sun rise exactly in the east and set exactly in the west—24th March and 25th Sept. Individual children can keep records of both time and apparent direction of sunset and sunrise. Ask children to notice which rooms get sunshine only in the summer.

Clouds

These are very interesting to study, and their constantly changing shapes are worth watching. They are composed of tiny water particles floating in the air. Water vapour when cooled takes this form. Watch the boiling kettle for visible water vapour.

Cloud shapes are often of definite types, and the children can be asked to watch for and record the following—

Cirrus—wisps of white cloud, sometimes called *mares' tails*, generally indicate *wind*, and are formed usually at over 25,000 ft.

Cumulus—large flat-based heaps of clouds. The top portion of each is generally dome-shaped. They are formed at below 10,000 ft.

Nimbus—dark rain or snow clouds.

Stratus—in layers like floating fog or mist.

(See diagrams PRACTICAL JUNIOR TEACHER, Volume II, page 377.)

Other cloud forms are rather too difficult for Junior children to study.

Nature Calendars

These are charts on which the children can record such observations as the first appearance of flowers, the habits of birds, the operations on the farms, and so on. Fuller details will be given under the headings which follow.

A chart on a large sheet of carton paper should be made out as follows—

Date	Flowers	Birds	Farm Operations	Name of Observer

Individual children can also keep daily diaries in which are recorded the observations each has made. A small notebook 6 in. × 4 in. is admirable for the purpose.

Suggested Syllabuses

The following are suggested syllabuses of weather observation for four years in a Junior School—

1st Year

1. Observation and discussion of weather
2. Simple sketch charts.
3. Elementary "wind rose."

2nd Year

1. Weather Charts.
2. Wind rose.
3. Daily rain depths recorded by the teacher
4. Daily temperatures—later on a chart
5. Length of shadow given by a rod
6. General daily weather conditions.

3rd Year

1. Wind rose—showing daily weather conditions.
2. Daily rain depths recorded by teacher and drawings made by children.
3. Daily temperatures—outside and inside—at 9 a.m. and 12 noon—charts
4. Observations of cloud shapes
5. Length of shadow given by a rod
6. Time and direction of sunrise—from diary and observation—once a month

4th Year

Complete weather chart showing—

(*a*) Wind—direction and force (Beaufort scale and words)
(*b*) Temperature—outside at 9 a.m. and 12 noon.
(*c*) Rainfall—readings from rain gauge recorded.
(*d*) Height of barometer (see Science section)
(*e*) Cloud shapes
(*f*) State of sky at 9 a.m., 12 noon, and 4 p.m.
(*g*) Time and direction of sunrise—weekly.

GERMINATION

Whether in town or country, observations can be made on the germination of seeds. Even the youngest children take pleasure in watching seeds unfold and develop into plants. The experiments which follow make a complete course in observation. The various experiments should be spread over the Junior School course.

Seeds

Children can readily recognize peas and beans, but there is no reason why some instruction should not be given so that they can recognize other common seeds. Any seedsman will make up a packet of mixed seeds for a few pence, or 1d. packets of seeds can be purchased.

Exercises in drawing and in description can be given in connection with the seeds. The following seeds are recommended for the first lessons in seed recognition—

Peas—note the smooth and wrinkled varieties, compare vegetable pea and sweet pea seeds

Beans—show the difference between the Broad Bean, Runner Bean, Dwarf French Bean (Canadian Wonder is a well-known variety). Later the differences in germination of the various kinds of beans can be noticed.

Turnip—the small round seeds are like shot (*cf.* cabbage family).

Lettuce—obtain some of the *white* and some of the *black* variety of seed.

Vegetable Marrow and *Carrot*.

Radish—notice the seed is not perfectly round.

Onion—typical shape and black in colour.

Tomato seed is expensive—of course, the flat "pips" in the tomato are the seeds. If one tomato is allowed to ripen fully, and then it is pressed out and the seeds are extracted, it will furnish plenty for classroom purposes.

Similarity of Seeds

One very interesting field of study in connection with seeds is to be found in comparing seeds from plants of similar habit. Marrow, cucumber, and melon seeds are very much alike. The seed of the onion is similar to that from the leek. Seeds from all the cabbage family are like small shot. It would be very difficult to differentiate between the seed of a "Savoy" cabbage and that of a "Spring" cabbage. Here an interesting point may be noticed: the seed of the swede and the turnip is similar in shape to that of members of the cabbage family—and it should be noticed that *all* the plants belong to the same group of plants with cruciferous flowers—though, of course, not all four-petalled flowers have similar seeds.

Wild Flowers

This question of the similarity of seeds can be further developed in connection with the collection of seeds from wild flowers. An examination

FIG. 8

Flowers of the Cornfield

(1) *Corn Marigold*; (2) *Field Pansy*; (3) *Poppy*; (4) *Scarlet Pimpernel.*

One of the reasons why it is difficult to clear land of "weeds" is that many of their seeds are, like those of the poppy, oily: this enables them if ploughed deep into the soil to lie dormant without rotting, and to germinate later if restored to a suitable level.

of the seed and a comparison with that of a cultivated plant will lead to a further study of the wild plant to see if it has any similar properties to the garden variety. The question as to whether wild and cultivated plants can be in the same family will lead to important lessons on the value of cultivation, and the methods man has adopted to develop the parts of a plant needed for food.

Seeds from Home

Once the interest of the children is stimulated in the examination of seeds, it will be found that many kinds of seeds will be brought from home. Many children will learn from garden-loving parents the names of the seeds, and will be then able to instruct the other children.

Use of Seeds

Why do people buy seeds? This question can be readily answered by children who have begged some seeds from a parent at seed-sowing time. Show them that plants develop from the seeds. The seeds begin to grow within the ground. Seeds that did not grow would be useless.

Seed Testing

Over half a century ago the scientists of Denmark and Germany began to see the importance of testing the seeds offered for sale by seed merchants and others. Obviously a farmer or gardener cannot afford to till and manure the soil and then sow seeds which have a very low percentage of germination. Further it is very annoying to sow seed and then to find that the seeds were not pure. Purity of seed is most important. As an example of this the case of clover seed might be described. Clover seed is sometimes spoilt by a mixture of dodder seed. The dodder plant is peculiar in its method of growing. After germination, the root goes down into the soil, and a threadlike coil untwists and lengthens out until it finds a *plant* on which it can live Having found such a *host* it clings to it and absorbs food from it. It then proceeds to send out threads in all directions to seize other hosts. So destructive is dodder that in less than three months one dodder stem may kill all the clover over an area of 30 square yards. What a calamity for a farmer who bought clover seed to find that he had clover and dodder!

To-day in many European countries, in the United States of America, and in a few of the British colonies regulations for the testing and sale of seeds have been passed. Special seed testing laboratories have been established where samples of *all* seeds to be sold are tested, and where samples of seeds may be submitted by prospective buyers Methods of testing the germinating power of seeds have been studied in these stations, and these will be described later, after the methods to be adopted in schools have been given (pages 740–1).

Germination

Germination, or *growth*, of the seed must depend upon certain conditions, and it should be the purpose of the school experiments to show what these conditions are. The Nature study teacher will, of course, realize that germination experiments can be carried out during the winter months when outdoor observations are difficult. Later it will be shown that the purpose of a *flower* is to develop *seed*, and that the *seed* is Nature's method of maintaining a continuous *life* stream even when climatic conditions are against continuous growth and maintenance of life in plant form.

Experiments Demonstrating Need for Water

Experiment 1. Fill a *dry* bottle with *dry* peas and cork up Leave for some days. Does any change take place? Does growth begin? Apart from this experiment, children will know that grocers keep dried peas for sale, and packets of dried peas will keep almost indefinitely.

Experiment 2. Place half a dozen broad bean seeds in a saucer of water and leave for some hours. Notice that the seeds have swollen. What has caused this? Carefully dry the seeds with a piece of clean rag. Squeeze one seed gently. Observe the point on the bean where the water comes out. Dry again, squeeze. Does the water again come from the same point? This small

hole, which is at one end of the scar, is called the *micropyle*, a word meaning *little gate*. If the question has not yet been asked it might be well here to find the cause of the black scar. It is here that the bean was attached within the pod.

Experiment 3. Soak some beans in a saucer of water. Observe these, say, every twenty minutes for some hours. Describe the changes which occur—(1) Wrinkling of outer coat or *testa* near the micropyle, (2) wrinkling spreads until the whole coat is affected; (3) the seed begins to swell and the coat is stretched again. It is well to have a bean of equal size, not soaked, so that the amount of swelling can be noticed. The explanation of the initial wrinkling of the skin is that the skin is moistened and swells almost at once, whilst the seed inside only gets moisture slowly at first. Later the wet seed begins to swell and increases in size to the new skin shape. Finally, of course, the seed increases sufficiently to burst the *testa*.

Experiment 4. To find whether the water enters through the micropyle proceed as follows.

Seal up the micropyles on a number of broad beans. Clay, rubber solution, or paint will serve to do this. Soak the beans in water and notice either (*a*) which gain most in weight in a given time (weighing before and after soaking), or (*b*) which beans germinate the more quickly.

Water can enter through the skin as well as through the micropyle, but more slowly.

Experiment 5. That a great deal of force is exerted by the swelling seed can be shown with a thin test-tube. Fill the tube with dry peas. Place the tube under water inside a jam jar full of water. Water will enter the test tube, the peas will swell, and the tube will break. Similarly a medicine bottle filled with peas and stood in a bucket of water can be broken.

Experiment 6. Leave some beans that have been soaked on top of moist sawdust. Notice that growth begins. Here it is established that *water* is the first essential for growth. The order in which growth takes place will be examined in later experiments.

Experiment 7. An interesting experiment on the rate with which water enters a seed can be made. In Experiment 4 it was shown that water enters more readily through the micropyle. It also enters through the skin. Thus, although the micropyle may be closed, yet the seed will germinate. Water enters the micropyle by what is known as *capillary attraction*. The word "capillary" is derived from a Latin word meaning a hair. Liquids which wet the sides of a vessel have the power of rising to a high level in a very narrow tube—a capillary tube. Oil is conveyed from the reservoir in a lamp to the burner up the tube-like passages between the wick fibres. Thus water enters the narrow tube of which the micropyle is the opening. Water passes through the skin of the seed by *osmosis*. In osmosis there is an interchange of liquid from both sides of a diaphragm.

To show the more rapid entrance of water through the micropyle proceed as follows.

Fill a bowl with moist sand. Insert six beans into the sand with the scar and micropyle out of the sand. Place six others with the scar within the sand. Keep the sand moist, and notice the difference in time taken for germination and growth to begin.

Experiment 8. Obtain six small flower-pots. Place stones over the holes and fill up with *dry* sand. Insert a bean in each pot at a depth of about ½ in. Water each pot daily as follows—

Pot 1. One teaspoonful of water.
Pot 2. Two teaspoonfuls.
Pot 3. One tablespoonful.
Pot 4. Two tablespoonfuls.
Pot 5. Three tablespoonfuls.
Pot 6. Four tablespoonfuls.

Record the first appearance of the bean shoot. What do you notice? In the pots receiving more water the seed will germinate more quickly. The first pot may not receive even enough to cause the seed in it to grow at all. The sixth pot will probably be later than the others. Too much water will cause the sand to be waterlogged. Growth will be retarded or prevented because *air* is excluded. This leads to the next series of experiments.

Experiments 1–8 aim at showing that water is essential to germination. Experiments 1, 2, and 3 should be taken in the first year, Experiments 1, 2, 3, 5, and 6 in the second year, and all of them in the third and fourth years. Groups of children can be in charge of each experiment.

Experiments Showing Need for Oxygen

Experiment 9. Boil some water. Let it cool. Soak beans in the water and let them remain. No germination will take place. Why not? When the kettle is placed on the fire or stove to boil water, a singing noise is heard shortly afterwards. This noise is caused by the little bubbles of air and carbon dioxide which are *dissolved* in the water, and which are being

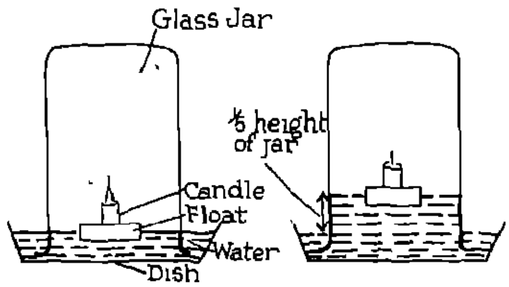


FIG. 9

Experiment to show that 1/5 of the Air is Able to Support Burning or Life

driven off by the heat. The fact that air will dissolve in water enables *fish* to live in water. Fish need air as much as animals. Later it will be shown that water in an aquarium must be aerated for this reason. Seeds need *oxygen,* the active part of the air, in order to germinate. It may be said that the air is made up of a *mixture* of gases. The two most important are. (*a*) oxygen—a colourless gas which supports burning and life, and which occupies about 20 per cent of the air; (*b*) nitrogen—a colourless inert gas which is present to dilute the oxygen and make its action less rapid (almost 80 per cent of the air is nitrogen). Other elements present are *carbon dioxide,* a gas which is formed whenever carbon burns in a plentiful supply of oxygen; *water vapour,* which is water converted by warmth; and then rare inert gases including *neon* and *argon.* Whenever growth takes place or *life* is present and active there is a combination of carbon and oxygen—carbon dioxide is made and oxygen is used up.

It may be found that seeds refuse to grow even in ordinary unboiled water. There is not sufficient oxygen for life to develop. The next experiment aims at showing, simply, something of the oxygen needs of the seed.

Experiment 10. Fill four glass jars with water, the first $\frac{1}{4}$ full, the second $\frac{1}{3}$ full, the third $\frac{2}{3}$

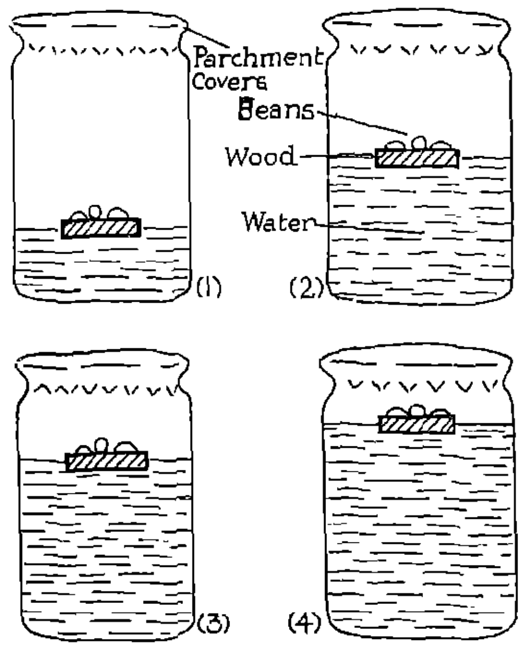


FIG. 10

Preparation of Experiment 10

full, and the fourth $\frac{3}{4}$ full. Cut 4 discs of wood, about $\frac{1}{8}$ in. thick and bore holes in them Float one disc on the surface of the water in each jar. Place six or seven beans on each disc, and then tie down the jars with waxed paper. Observe the rate of germination.

Experiment 11. After the seeds have been growing for some days in the jars in Experiment 10 remove the waxed top and plunge in a lighted taper. Notice that the flame is extinguished. This shows that the *oxygen* must be used up. It does not prove that carbon dioxide has been formed. This can be shown as in the next experiment.

Experiment 12 Fill a potted-meat jar with water and stand it in a glass jam jar. Tie up twenty to thirty peas in a muslin bag and hang

the bag from a large cork fitted in the jam jar. Adjust the string so that it will just allow the muslin bag to hang in the water in the meat jar Leave for four or five days. Remove the cork and pour a quantity of *lime water* into the bottom of the jam jar. Notice the lime water turns milky. This shows the presence of *carbon dioxide*.

To Make Lime Water. Purchase a pennyworth of quicklime from a builder. Pour a small quantity of water on to the lime whilst it is standing on a dry saucer. Great heat will be given off, steam will arise, and the lump of quicklime now

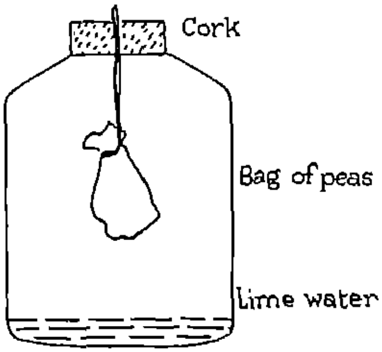


FIG. 11

Experiment 12 · *Demonstrating Presence of Carbon Dioxide*

The meat jar with water is placed under the bag of peas

will *slake* down to a powder. Stir the slaked lime round in a jug full of water. Filter the water or allow the lime to settle and decant off the clear liquid

It is well at this stage to allow children to breathe air through a glass tube into a little lime water, and to notice that it turns milky. Thus people breathe in good air—containing oxygen—and breathe out air containing carbon dioxide. The similarity to the needs of a growing seed is worth noticing.

Up to this point it has been established that a seed needs *Moisture* and *Oxgyen* in order to germinate.

Effect of Temperature

There is one other essential factor, and that is a suitable *Temperature.* In this connection think of the seasons. In spring growth begins as the daily temperature rises. In summer flowers develop and seeds form. The ripened seeds are scattered in the autumn. The seeds lie dormant in winter. For all seeds there is a temperature below which they will not grow. Above a certain temperature growth will not take place. These represent the minimum and maximum temperatures. The range between them is the variation in temperature in which growth will take place. The most successful germination and the most rapid growth occur at the *optimum* or best temperature.

Experiments on the influence of temperature on germination are not so easy to arrange as some of the others. Seeds of the broad bean kept moist but placed in a box containing a mixture of ice and water will not germinate. Seeds will germinate more quickly in a warm room than out-of-doors. The influence of heat upon the germination of seeds can be tested as follows.

Experiment 13. Boil some water in a beaker. Immerse dry and soaked beans in the water for various intervals—from one minute to five minutes. A tiny cotton or muslin bag will do to hold each seed in the water. Label each seed and place in earth to germinate. Note which grow and which do not.

More accurate experiments can be done by which seeds are kept at lower temperatures for a long period, and the germinating power tested.

Effect of Light

One other experiment should be tried before the details of growth are observed.

Experiment 14. Place a little water in the bottom of two glass jars. Put six broad bean seeds in each Obtain a large tin which will just cover one of the jars. The two jars, one covered and one uncovered, should now be left on a shelf while the beans germinate. The question to be answered is: Will the beans germinate more quickly in the light than in the dark? It will be found that *darkness* encourages germination. Notice that this is similar to Nature's conditions for a seed within the soil.

It has been established that a seed will germinate better in the dark than in the light,

and that moisture, oxygen, and a suitable temperature are needed for germination to take place.

Experiments 9–14 should be carried out in the third year. The youngest Juniors can be shown that seeds cannot germinate if air is not present, without going into details. The effect of temperature on growth can also be discussed generally, in relation to the use of a greenhouse.

Observations upon Growing Seeds

The next stage will be to watch the actual growth of seeds of various kinds. It is well to provide certain pieces of simple apparatus for this purpose. The following are suggestions—

1. Glass jam jars. Place the seeds against the glass. A piece of blotting paper, at least two layers, should be fixed to hold the seeds. Fill

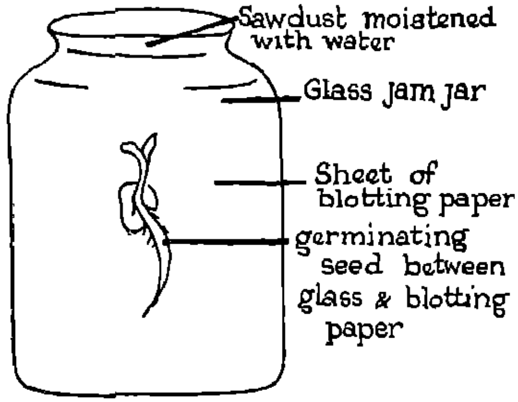


FIG. 12

Seed Germinating in Jam Jar

up the centre with damp sand, damp sawdust, or sphagnum moss (purchasable at a chemist's). Fibre in which bulbs are grown will do equally well

2. A lamp glass can be fitted up similarly. The glass should be placed in a dish of soil in order to prevent it from being knocked over easily. It might be fixed into a clay or plasticine base, or the lower part may be filled with sand.

3. A glass front might be fitted into a wooden box. This may easily be done as follows. Remove one side of the box. Obtain a piece of glass just the size of the *space*. Tack on some narrow strips of wood to the ends of the open side of the box. Place the glass inside and touching these strips. Fill up the box with soil. The weight of the soil will press the glass forward.

4. Observations of roots of seedlings can be made if the glass slopes inward. Remove one side of box. Nail two strips of wood diagonally

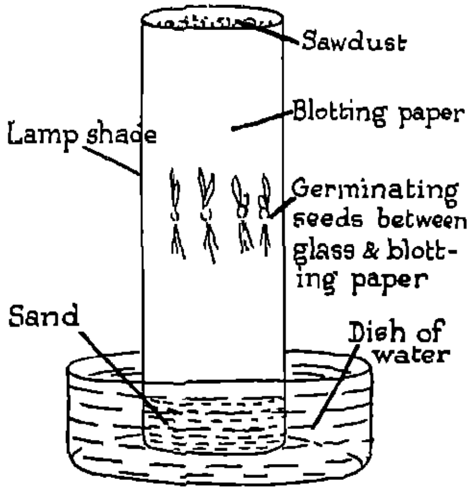


FIG. 13

Lamp Glass Showing Germinating Seeds

across the ends. Fill with soil after supporting the glass on the strips.

5. For counting the percentage germination of seeds obtain a tin lid 10 in. × 10 in. Cut a pad of blotting paper six or seven layers thick, or provide a thick piece of felt. Divide the top sheet of blotting paper into 100 1-in. squares. Saturate the whole with water. Take a hundred seeds from a sample to be tested. Place one on each square. Cover the whole over with another layer of damp blotting paper and place in a warm place. Moisten the whole daily. Make a count of number germinating after two days, three days, etc. After a week take germinating percentage.

The most easily observed seeds are the larger ones, such as the broad bean and the pea.

The Broad Bean—drawings should be made at each stage, and they might well be larger than the seedlings sketched. (See Figs. 16 and 17.)

The following notes are given as a guide to observation. Soak a broad bean, carefully remove the skin. It will be found possible to open out the seed into two halves.

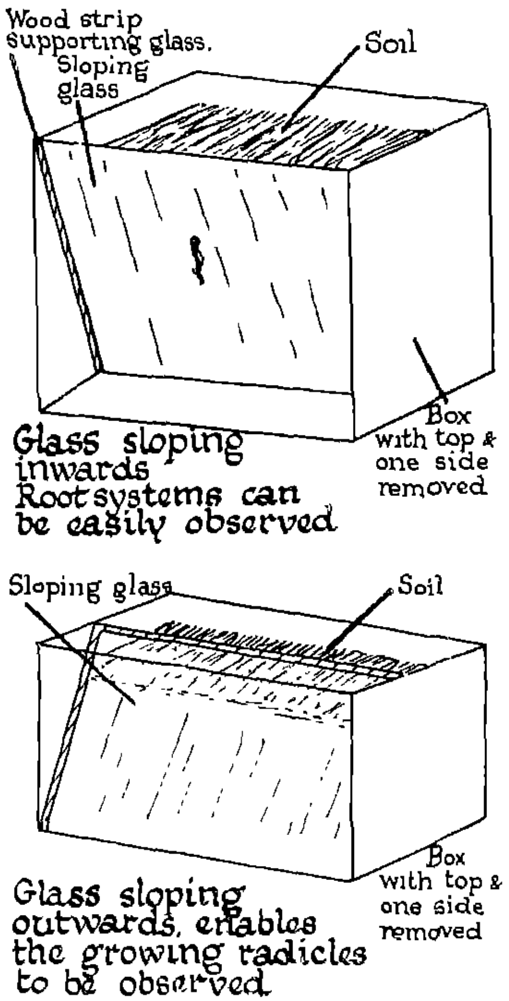


FIG. 14

Box Fitted with Glass Front for Observation

Each of these is a *Cotyledon* or seed-leaf. Lying between them and near to one edge can be seen the *plumule* or growing shoot, and, jutting out below, the *radicle* or primary root These three —(*a*) the cotyledons, (*b*) the plumule, and (*c*) the radicle—constitute the embryo plant. From this examination it is easily seen why the root pushes its way out of the seed first. Now insert some soaked seeds in one of the germination jars, and make sketches each day after growth has started. Notice—

(*a*) The shape of the flap raised by the emerging radicle.

(*b*) The exact place where the radicle emerges.

(*c*) The way in which the radicle grows.

(*d*) The time that clapses between the emergence of the radicle and the first appearance of the shoot.

(*e*) The bent manner in which the shoot emerges (Note protection afforded by this bent form)

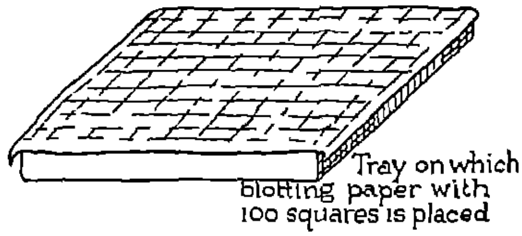


FIG. 15

Tray Prepared for Percentage Experiment

(*f*) The colour of the young shoot on emergence, and the time that occurs before it becomes green.

(*g*) The time before tiny hair roots appear on the radicle.

(*h*) The rate at which the root grows compared with the shoot A graph of this would be interesting. How long is it before the shoot grows faster than the radicle?

(*i*) What happens to the cotyledons as the bean seedling grows? The gradual shrivelling of these seed-leaves suggests that the food within them provides nourishment for the young plant.

Food of Seedlings

The last observation on the shrivelling cotyledons suggests that the question of the food supply for the germinating seed should be considered.

The information given here is for the use of the teacher This will form a background for the work and is not intended to be taught, as it stands, to the children.

If two broad beans are allowed to germinate

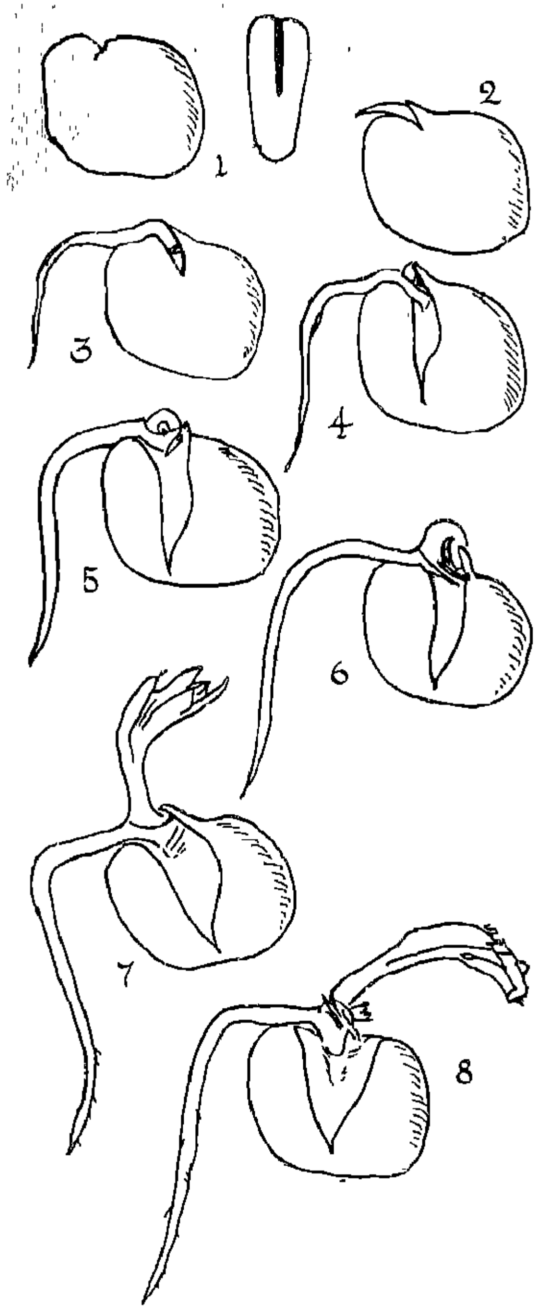


FIG. 16

Stages 1–8 *of Growth of Broad Bean Seedling*

side by side the feeding properties of the cotyledons can be observed. As soon as the root (radicle) has obtained a firm hold in the soil carefully remove the cotyledons from one plant, taking care not to damage the rest of the plant. The difference in the further development of this plant in comparison with the normal one will well illustrate the value of the food in the cotyledons. (See Fig 19.)

It does not come within the scope of this course to show how to analyse the seed-leaves to find what food is contained within them. Held in a flame the seed-leaf blackens, showing the presence of *carbon*. The fact that nitrogenous foods and oils and fats are present can be shown, and mineral salts are also there. Thus a plant requires food with the same constituents as that required by human beings. The carbon is present largely in the form of *starch*. A very simple test for starch is provided by means of iodine either in solution in alcohol or dissolved in a solution of potassium iodide. A chemist can supply either of these for a few pence. A blue colour is given with starch.

Digestion of food is necessary within the human body to make it soluble. Starch is not soluble in cold water, but the saliva of the mouth has the power of converting starch into sugar. Similarly, various juices in the stomach and intestines can make proteins (the nitrogenous foods) and fats digestible. Of course, mineral salts are already soluble in water, and can pass into the blood.

The plant food contained in the cotyledons is not soluble, and could not, unless changed in some way, assist the growth of the seedling. There must, therefore, be some wonderful changes in the seed-leaves by which indigestible food becomes soluble. These changes are almost similar to those which take place within the human body.

Starch is converted into sugar in the seed-leaves by a juice or ferment called *diastase*. Juices something like those found in the stomach and intestines convert *Proteins* into soluble *Peptones*, and even less complex substances. This juice in plants is known as *trypsin*. Other ferments emulsify the oils and fats. These ferments begin to act as soon as moisture enters into the seed

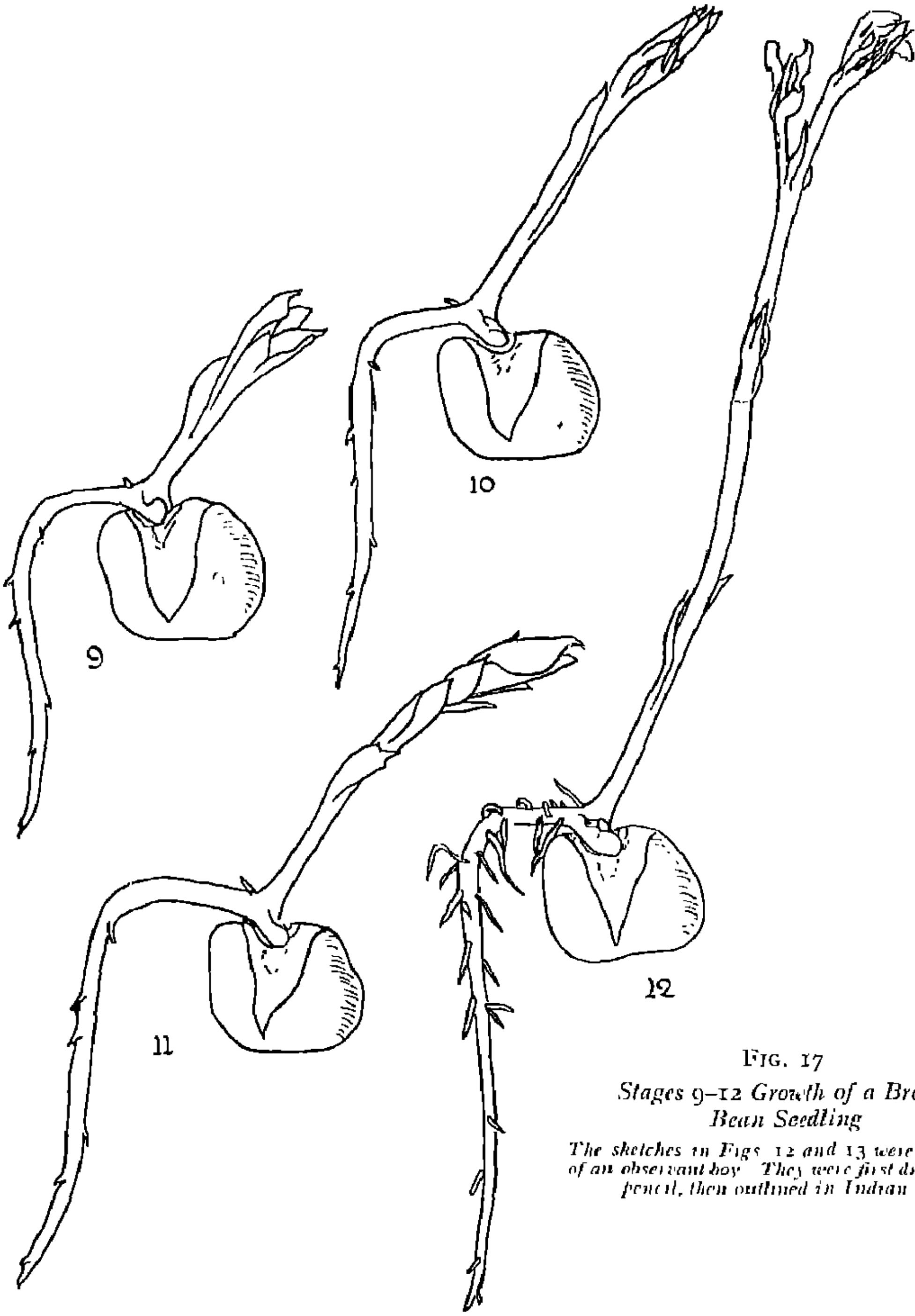


FIG. 17

Stages 9–12 Growth of a Broad Bean Seedling

The sketches in Figs. 12 and 13 were the work of an observant boy. They were first drawn with pencil, then outlined in Indian ink.

Further food for the developing seedling must be obtained from other sources. The root has the power of taking food from the soil, and the leaves can absorb further food from the atmosphere in the presence of sunlight. These methods of feeding will be discussed in a later section.

Up to this point the main observations have been made upon the seed of the broad bean, a seed which contains two well-defined cotyledons within the seed. As the growth of the seedling develops the seed leaves shrivel. They are not carried above the level of the soil. Other seeds which behave similarly are the *acorn* and the

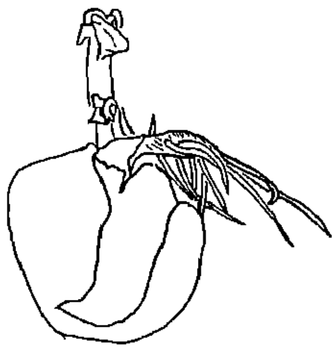


FIG. 18

Bean Seedling of which the Root-end was Broken Off

Notice how new roots are growing Experiments of a similar nature can be tried.

pea. Such seeds are said to be examples of *Hypogean* germination (Greek *hypo*, under, and *ge*, the earth).

Experiment 15. Soak and then place in a glass-fronted box a number of French beans. Watch and draw the various stages of growth. Notice that the cotyledons are drawn out of the soil. Observe what happens to these leaves as the young seedling develops. Watch particularly for the initial shape of the radicle.

Experiment 16. Carry out as Experiment 15, but carefully remove one cotyledon from a bean. Try to find what part of the growing seedling develops, and so carries up the seed-leaf

Experiment 17. Sow half a dozen seeds of *mustard* in a 4-in. pot. Watch carefully what happens. At the same time, sow some mustard seed on wet flannel.

Notice—
1. The opening of the seed.
2. The rapid development of the stem.
3. The seed-leaves carried up.

Photo *W. B. Little*

FIG. 19

Broad Bean Seedlings With and Without Cotyledons

Both seedlings were planted on the same day; that on the left growing normally, that on the right having had the seed leaves removed soon after growth commenced

4. The second pair of leaves which develop on the plant. Make a drawing of the seed-leaves and the first pair of real leaves. Their shapes are quite different.

Epigean germination (*epi*, above) occurs when the seed-leaves emerge from the ground. The true function of the seed-leaves is not realized in the case of the French bean. It might almost be said that here is a type between the hypogean and epigean.

Experiment 18. Sow two pots with a dozen seeds of mustard. Cover one up so that it is in darkness Follow the development of the plants. Observe that the seed-leaves cannot function in darkness.

Seeds in which Food is Stored Outside the Seed Leaves. The embryo, or living centre of a seed, has been connected to cotyledons in the seeds that have been discussed up to this point. The initial food has been obtained from these leaves. There is another type of seed which must be considered. An analogy might be made here with the hen's egg The chicken during growth within the egg can use up a reserve of food which is within the egg but independent of the embryo. A grain of wheat represents a type of seed in which a similar store of food independent of the life-germ is found. The embryo lies at one corner of the grain within the husk. The major part of the contents of the seed-case consists of starch. This reserve of food for the baby plant is not attached to the embryo. The "flour" used as food is made up of this starch. The part of the seed where stored food is to be found is known as the *Endosperm*.

Seeds of which the food supply is outside the embryo are termed *endospermic* or *albuminous* It should be stated that the term albuminous is misleading, as the contents of the endosperm are not necessarily albuminous. In the cereals the endosperm is largely made of starch; in castor oil seeds the endosperm is oily

Seeds to Observe

Dicotyledons and Monocotyledons. The bean and pea family and mustard and cress have all *two* seed-leaves. Some consideration must, however, be given to the large number of seeds that produce but one seed-leaf, and are, therefore, termed *monocotyledons*.

Experiment 19. Place some onion seeds in a germination jar. Watch and describe the method of growth. At the same time place some onion seeds on moistened flannel. Keep in a warm cupboard and observe closely.

Notice—

1. Little swelling of seed on soaking. This may be due to the very hard case.

2. The first appearance of the radicle. It looks like a little white spot

3. Rate of growth of radicle.

4. First appearance of cotyledon. Observe the arched shape.

5. Raising of the seed case.

6. Cotyledon tip remains within the seed case until all food is absorbed.

Experiment 20. Soak a maize seed in water for several days. Plant in a germination jar. Observe growth and make drawings. Examine soaked seeds also.

In the seed notice—

1. Which end was attached to the corn cob.

2. The two flat sides—find the oval white-coloured depression on one of these faces. This gives the position of the *embryo*; the remainder of the seed is endospermic.

3. When the seed coat is removed from a soaked seed it is easy to distinguish between the embryo and endosperm. If the cotyledon is moved the radicle and plumule can be examined.

In the germinating seedling notice—

1. A slight increase in size after soaking.

2. The radicle emerges first

3. The plumule and the protecting of the growing point.

4. The other roots which develop (*cf.* bean).

Other seeds which should be germinated because of interesting features are as follow.

1. *The Seed of the Castor Oil Plant.* Obtainable from a chemist. It has a double coat and is endospermic. At one end of the seed is a spongy mass called the *aril*. Water is sucked up by this and passed to the radicle.

2. *Vegetable-marrow Seed.* Particularly interesting because the cotyledons are enabled to escape from the seed in a peculiar way A kind of hook develops from the lower half of the seed and pegs it to the ground. The growing shoot pushes up the top half and escapes

3. *Sycamore.* The cotyledons are rolled up inside and are green *before* emergence.

4. *Wheat* can be germinated and will give very similar results to maize

5. *The Horse Chestnut.*

6. *The Nasturtium.* In this case note particularly the shape of the seed-leaves.

7. If a greenhouse is available a *date* stone may be planted.

8. Very easy seeds to germinate are any of the *cabbage* family. Turnip and swedes.

9. *Beet.* Notice that one capsule is a cluster of seeds.

10. Obtain common *weed* seeds and note their habits of germination

Junior School Syllabuses

It is suggested that the germinating of the following seeds should be watched in the Junior School—

1st year. Broad bean, pea.

2nd year. Broad bean, pea, mustard and cress.

3rd year. Broad bean, French bean, onion seed, grass seed, marrow seed, sycamore.

4th year. Pea, leek, wheat, chestnut, castor oil seed, nasturtium, beet.

Soil and Plant Growth

Experiment 21. To see whether seeds germinate better according to the depth of soil, take the glass-fronted germinating box. Place seeds of the broad bean down the centre of the glass. Keep the soil moist and observe the rate of germination. In general seeds should not be covered to any great depth—four times the diameter of the seed is a good rule.

Nature's Sowing. It is well to remember that seeds in their natural state are scattered on the top of the soil. Ultimately many do get covered with earth Worms assist in this process. Rainstorms and other natural agencies also help to cover the seeds with soil. Once a lady wishing to grow sweet peas asked a friend how deep she should sow the seeds. "About 4 in.," he replied. On commencing to do the work the lady remembered the four but thought her friend had said 4 ft. With much labour she made very deep holes and dropped a seed in each. She is still waiting for the seeds to grow. The farther down in the top soil that one goes the colder it is. The soil is often waterlogged, and no air is present. Thus germination cannot take place at such levels.

Experiment 22. Can a seed grow without soil or material in which to grow? This question has been partly answered already. Beans, peas, and other seeds have germinated on saucers.

Copper wire can be wrapped round a bean seed and it can be suspended from the neck of a glass jam jar. Water should be put in the jar to within 2 in. of the bean, which should be soaked before being placed in its "stirrup."

Root and Stem Growth

Up to this point nothing has been said about the directions in which the root and stem grow. We assume, of course, that the root will grow down into the soil and the stem with its growing shoot will ascend vertically. What conditions govern these directions of growth will be the purpose of the next series of experiments.

Each of these experiments can be supervised by a group of children. The purpose of the experiment should be explained: for example in Experiment 23 the teacher should say "We want to find out which part, if any, of the root grows most quickly." Then discuss methods of doing this and then get the experiment working.

Experiment 23. What part of the root grows most quickly? Hang up a soaked bean as in Experiment 22 When $1\frac{1}{2}$ in. of root have emerged carefully dry the root by dabbing with cotton wool or blotting paper Make lines with Indian ink $\frac{1}{8}$ in apart, starting from the tip. Let growth continue. It will be found that the marks near the tip soon become wider apart, while those near the bean do not. Thus growth is most active just behind the growing tip.

Experiment 24 Sow a bean in a small pot. When the shoot is some 2 or 3 in. high mark off as the root in Experiment 23. Notice that growth is most active just behind the growing tip.

Experiment 25. Sow a bean in a pot. Over the bean place a layer of plasticine. Notice what occurs. The power of the growing tip to pierce obstructions is remarkable. Tender blackberry shoots have been seen to force their way through asphalt.

Experiment 26. Place $\frac{1}{2}$ in. of mercury on the bottom of a glass potted-meat pot. Put $\frac{1}{2}$ in. of water over the mercury. Germinate a broad bean until its root is about $1\frac{1}{2}$ in. long. Plug the pot with a cork from which a circle has been bored. Push the root through the hole in the cork, lower the bean on to the cork, and pin it with three pins. Observe the growth of the root. Mercury is 13·5 times as heavy as water. Notice the power of the growing root. Other experiments can be devised to show this, using a small postal balance.

Experiment 27. Place three bean seeds in a germination jar—one with the scar downward, one upward, and one sideways. Make sketches to show the exact manner in which the radicle descends and the plumule ascends.

Experiment 28. Place blotting paper round the inside of a glass jar. Insert a bean and fill up the jar with damp moss. When the radicle is at least 1 in. long turn the pot upside down and notice what new directions the root and shoot take. After two days in this position reverse the jar and see what happens again.

Experiment 29. As Experiment 28, but lay the jar on its side. Notice where the curving of the root and stem takes place.

Gravity

The root grows downward because of the action of gravity upon the growing tip. This latter fact can be proved by experiments.

Experiment 30. Mark the radicle and plumule of a broad bean seedling as in Experiment 23. Lay it in a darkened cupboard so that the root and shoot are horizontal. Examine after twenty-four hours and see where the upward curvature of the plumule has taken place.

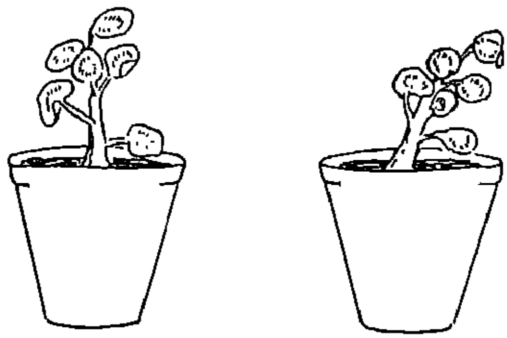
Moisture and the Pull of the Earth

Experiment 31. The question will arise as to whether any other cause can deflect the root from its vertical and downward path. Scatter peas or other suitable seeds (after soaking) on a cake tray or box with gauze bottom. Place layers of moist blotting paper on top. Hang up the tray or box and observe what happens. The roots will come through the wire and grow downward for some time. Later the roots will curve up toward the source of water.

Experiment 32. Place a porous pot in the centre of a box of sand. Fill the pot with water. Place mustard seeds in the sand near the pot. After three days carefully remove the pot and notice that the roots of the germinated seeds all grow toward the source of water.

Thus it can be seen that the demand of the root for water overcomes the geotropic movement due to the earth. Obviously this is a good thing. A tree or plant root within the soil can search out a water supply.

The force of gravity can also be overcome if certain obstructions are in the path of the grow-



(*a*) *Plant Growing in Full Light* (*b*) *Plant in Window Growing Toward Light*

FIG. 20

ing tip of the radicle. The power of penetration of this root tip is enormous, but hard stones, rock, and similar substances sometimes cause the root tip to be deflected. Immediately the obstruction is passed the original path is continued. Certain chemicals also act upon the root tip and cause it to alter its path.

Influence of Light on the Stem

Does the stem always grow perfectly vertically? Many will have noticed that where plants are grown in pots in a window the leaves and flowers stretch toward the light, and the whole plant bends toward the window. If the pot be turned through an angle of 180° so that the plant slopes in toward the room, it will be found that

the plant will rebend toward the light. Experiments which show the influence of light on growth can easily be carried out.

Experiment 33. Sow some mustard seeds in a small pot. Cover with a large pot but leave $\frac{1}{8}$ in. space round the bottom. Observe the way in which the leaves endeavour to reach the light.

Experiment 34. Obtain a tea chest or other large box. Fix up the cover so that a slit 6 in. × $\frac{1}{4}$ in. is cut in the centre. Place various plants

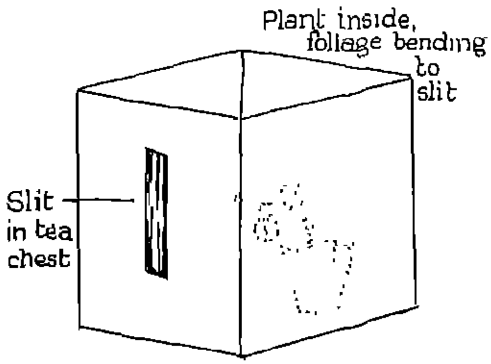


FIG. 21

Experiment Demonstrating Attraction of Light

in turn in the box—placed on its side—and observe the influence of light coming in only one direction, through the slit.

Leaves and Light

It will be noticed in all experiments on germination that plants grown in the dark are white or yellow, not green. Further, on being brought into the light the leaves become green The following experiments will demonstrate something of what processes occur in the leaves in daylight—though the main work on leaves will come later. These experiments are for the teacher to perform. It will be sufficient to show the children the change in colour and to explain the work of the sun in a simple way.

Experiment 35. Place two geranium plants grown in pots in a dark cupboard. Keep watered. After two days when the sun is shining brightly bring out one plant and leave it in the sunshine for several hours.

Pick a leaf from the plant in the dark cupboard and from the one in the sunlight. Steep the leaves in boiling water for three minutes. Take out and place in spirit. Gradually the green colour of the leaves will go. The spirit is dissolving it out of the leaves. This green substance in leaves and plants is called *chlorophyll*, and is soluble in spirit or alcohol. (Here is a suggestion for removing grass stains on "flannels.") Remove the bleached leaves and dip in some of the iodine solution used in an earlier experiment. The leaf from the plant exposed to sunlight turns a blue colour whilst the other leaf does not give the same change. Remember the blue coloration shows that *starch* is present. The question might well be now asked: How can we tell that the starch is present because the plant was placed in sunlight? The only fair way is to put both plants back in the dark cupboard again and later bring out *the other* plant into sunlight and see if *starch* is made in its leaves.

Experiment 36. Make a drawing, in colour, of a variegated privet spray or leaf. Place in boiling water for three minutes and then steep in alcohol. When the chlorophyll has all dissolved out of the leaf test with iodine. It will be found that starch is present only in that portion of the leaf that was originally green.

It is thus clear that in the light the leaf has the power of producing *starch*. The question arises as to how this starch is made. Starch is composed of carbon, oxygen, and hydrogen. The carbon is obtained from the carbon dioxide in the atmosphere. Where none of this gas is present no starch can be made even in daylight.

Experiment 37. Place a pot plant in a dark cupboard for three days. Bring it out and place it under a glass jar, standing the plant and jar in a large saucer or basin. Fill the saucer with sodium hydrate. This will absorb all the carbon dioxide After some hours test the leaves for starch. There will be none present.

Thus in sunlight the leaf can manufacture food for the plant. Here can be seen the important work that is done by cotyledons which come to the surface early, turn green because of the development of chlorophyll, and make food for the baby seedling.

Pots and Soil for Seed and Plant Growing

It will be necessary for the teacher to obtain a number of pots and a quantity of soil for the germination experiments. Further, in every school, whether Nature study figures in the syllabus or not, plants and seedlings should be cultivated in order to beautify the school rooms. The most useful pots are the unglazed terra-cotta flower pots. Pots are sold by number and diameter across the top. For reference the following table will give some idea as to the various sizes.

Number in a cast	Inside diameter across top, in inches
72	$2\frac{1}{2}$
Small 60	$2\frac{3}{4}$
Mid. 60	3
Large 60	$3\frac{1}{2}$
Small 54	4
Large 54	$4\frac{1}{4}$
Small 48	$4\frac{3}{4}$
Large 48	5
40	$5\frac{1}{2}$
32	$6\frac{1}{4}$
28	7
24	$7\frac{1}{2}$
16	$8\frac{1}{2}$
12	$9\frac{1}{2}$
8	11
6	$12\frac{1}{2}$
4	14
2	$15\frac{1}{2}$
1	18

In addition to flower pots, seed pans may also be purchased. (See Fig. 27.)

Cleansing Pots and Seed Pans

The first work at the beginning of the potting season should be to clean and soak the pots. Old pots that have been used in the previous season will be dirty. Spores of small plants or moss may have developed upon them. The dirty pots are not porous, and there may be, in addition, spores of disease which will infect the seedlings and plants placed in the pots. Therefore the pots should be well scrubbed and then washed in running water. Pots should be soaked in water before use. The reason for this is readily seen when it is realized that the pots are porous. If a perfectly dry pot is filled with soil and a seed or plant is placed in the pot then the pot itself will absorb considerable moisture. Though soil conditions might have been quite right before, this absorption of water might make all the difference between success and failure.

Soil

Special attention should be given to the provision of good soil for pot cultivation. There are several ingredients required—

1. Loam—this is best obtained by stacking in layers with soil uppermost a number of turves obtained from old pasture land. It may require from twelve months to 2 years for the whole stack to rot down to the best condition, but some good loam can be obtained earlier by passing some of the pieces through a sieve. Watch should be kept for insect pests which may survive in the soil.

2. Leaf mould—this can be secured from a wood. Failing this any decayed vegetable matter might suit. Leaf mould and loam can also be purchased at a seedsman's shop.

3. Well rotted manure—if a little can be obtained from an old hot bed it will be found suitable.

4. Clean river sand—this will lighten and aerate the soil.

5. Wood ash mixed with the other ingredients is helpful, as it contains phosphates. The charcoal in it has purifying effects.

The ingredients should be mixed with a trowel or small shovel on a board, and the whole should be easy to handle. If very dry the mixture should be watered and turned. The soil should not, however, be made wet and sticky.

Preparing Pots for Seedlings, Plants, etc.

Having cleaned and soaked the pots the next thing is to fill them with soil. Material to ensure drainage must first be put in. Broken pieces of pots (called *crocks*) should be obtained. Put at the bottom of the pot a large piece which almost covers it Add several smaller crocks. A little moss or coco-nut fibre will assist drainage if placed on top of the crocks. The soil, made up

in the proper mixture to suit what is to be grown in the pot, should be now added.

Watering Pots

Plants require water in varying amounts, which depend on the season of the year, the temperature, and the size of the plant. If a pot is gently tapped with a stick or the knuckle a hollow sound indicates the need for water A great mistake is often made in drawing water

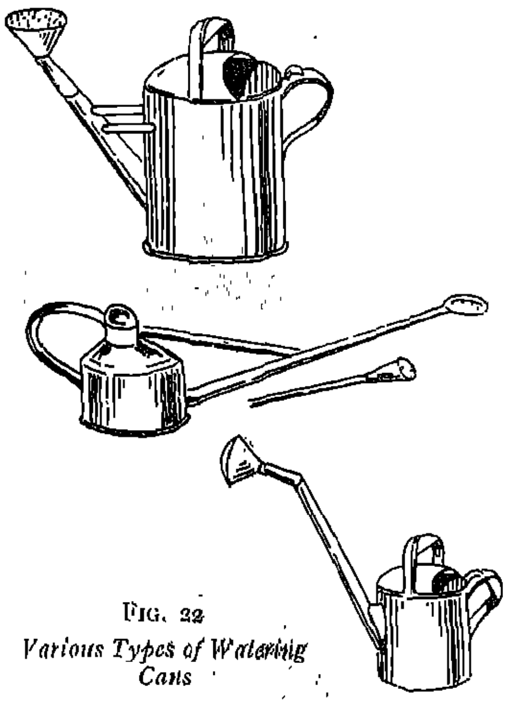


FIG. 22
Various Types of Watering Cans

from a tap for watering purposes. This water is bound to be colder than the temperature of the room or the soil. Water for watering should be placed in a bucket or tank and allowed to stand. It will then become of the same temperature as the room. In greenhouses such tanks are provided. Soft water is better for watering than hard tap water. A good soaking every three or four days is much better than a little water every day. This applies equally in the garden Examination of the soil after a short watering will show to what a little distance the water has soaked. Surface watering attracts the roots near to the top of the soil. A fierce day's sunshine will then do great damage to the delicate roots

Window Boxes

These can be fixed either inside or outside the school windows. If inside, the plants grown in them will consist of ferns, ornamental-leaved and flowering plants which bloom within doors. Bulbs may be grown in them in winter and spring, whilst geraniums, petunias, and many half-hardy annuals can be cultivated in summer. The more usual type of window box is that placed on the outside of the window. These boxes add gaiety and colour to the school from spring until late autumn. Further, the successful growth of plants and flowers in window boxes at school will encourage children to establish window gardens at home even when there is no garden. Window boxes should be constructed of oak or chestnut, and they should be at least 9 in. in depth, and a little wider than the sill on which they are to rest. Window sills generally slope downward from the window-frame so that drainage of rain can take place easily. Wooden supports must be provided for the window box, so that the bottom of the box is level. A space must be left between the bottom of the box and the ledge. Otherwise water will collect, and rot either the box or the ledge or both. Holes of about ½ in. diameter should be forced in the bottom of the box. Window boxes may be treated in either one of two ways—

1. The box may be filled with soil and the seeds and plants may be put in the soil to grow. In this case broken crocks, small stones, and clinkers should be placed in the box to a depth of 1 in. Then a layer of turf with the grass undermost should be placed on the top of the stones Fill up to 1 in of the top with a mixture of loam, leaf mould, and silver sand well sifted and mixed together.

2. The seedlings and plants may be grown in pots and these pots may be stood in the window box. The box should be filled with ashes or gravel to give stability and warmth to the pots This method has an advantage over the other in that a succession of flowers can be readily maintained. When flowers in one set of pots

have finished blooming they can be replaced. It is usual to make the front of the window box decorative. Virgin cork can be fixed to the front or the box can be painted a bright colour with the new cellulose paints. The inside of the box should not be painted.

BULB GROWING

A deal great of pleasure can be obtained from growing bulbs in school. The bright colours of the flowers in winter and early spring, when few are to be seen elsewhere, are much admired. Further lessons in plant development and germination can be taught. There are three main ways in which bulbs may be grown in schools—

1. In bowls having no drainage, the bulbs being planted in fibre.
2. In glass jars; the bulbs usually grown in this way are hyacinths.
3. In pots in soil.

1. *Bulbs in Bowls*

Choice of Bowl. Material does not much matter. China, porcelain, clay, or even varnished papier mâché will do.

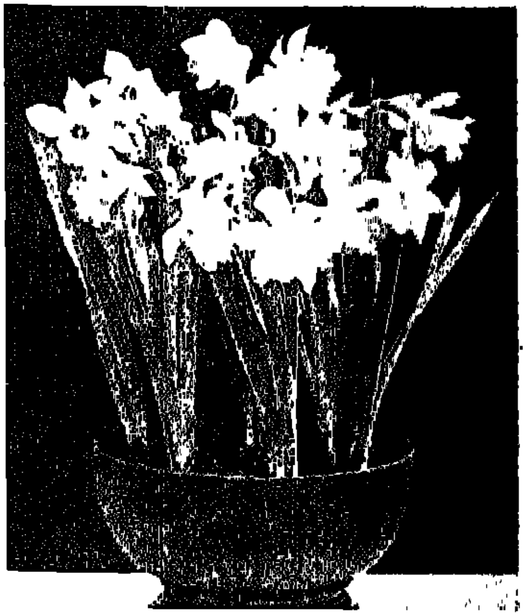
Colour, however, does need some consideration. Care must be taken to see that the colour of the expected flowers will be in harmony with the colour of the bowl. Black bowls are very good for this reason. Glass bowls are interesting as the root development can be watched.

Size must be considered. Shallow bowls are not useful. For narcissi and daffodils bowls should be at least from 5 to 6 in. in depth. Hyacinths need at least 4 in. A diameter of 7 in. is a useful size.

Preparing a Bowl Fibre for the bowls costs a few pence a pound, and can be bought from a seedsman. It should be placed in a large enamel bowl or bucket and covered with water. After a thorough soaking the fibre should be taken out and squeezed. It should not be too wet when placed in the bulb bowl—no water should drip from it if gently squeezed. A layer of the fibre is then placed in the bottom of the bowl so that the bulbs placed in it will be almost covered when the bowl is filled to within $\frac{1}{2}$ in. of the top of the rim. It is a good plan to place a cinder or two and some pieces of charcoal at the very bottom of the bowl. This counteracts over-dampness.

[illegible] so that [illegible], and $\frac{1}{2}$ in. space [illegible] the sides [illegible] the bulbs [illegible]. [illegible] should not [illegible].

[illegible] The first essential [illegible] the bulbs develo proots.



Messrs. Sutton & Sons

[illegible]

[illegible]

[illegible] bowls in a *dark*, [illegible] *air*. A cellar [illegible] will not do, [illegible] The bowls must [illegible] weeks, by [illegible] appear [illegible] devel-oped. The fibre must be kept moist. If the fibre has been properly damped at the beginning

there will be little need to add much water whilst the bowls are in darkness

Further treatment consists in bringing the bowls out into the light. Violent changes of temperature and draughts should be avoided. As growth proceeds more water will be required but care must be taken at the same time not to over-water.

Subjects for bowl culture are as follows—

Hyacinths—three in a 7-in. bowl will give an idea of the size. The same variety should be grown in one bowl The large flowering varieties are the best.

Daffodils—deep bowls are required Those of a very tall habit should be avoided. Sir Watkin, Golden Spur, and Princeps are three good varieties.

Tulips—these do not always give such good results as the others. The Darwin tulips are not recommended as they are late. The early single and double tulips should be purchased for growing in bowls.

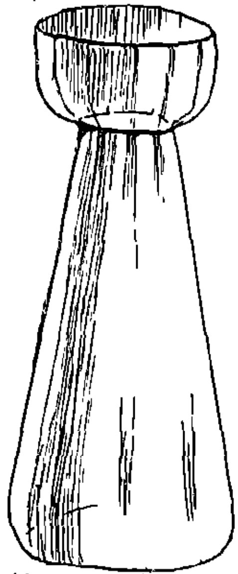
Other bulbs may be grown in bowls, but the greatest success will be attained by keeping to these varieties and planting one kind in each bowl.

Time of Planting. For a display early in the winter the bulbs should be inserted soon after the summer holidays. Other bowls can be planted at intervals for succession.

2. *Bulbs in Glass Jars*

Special glasses can be obtained for growing hyacinths. It is not recommended that other bulbs should be grown in this way. The glasses should be filled with pure water. A lump of charcoal should be added, as this keeps the water fresh; generally there should then be no need to change the water. The bulb should be so placed that the water only just touches the base. If more of the bulb than this is covered there is a danger of the bulb's rotting. The glass and bulb should now be placed in a dark, cool, but airy place in order that root development may take place. At least six weeks will be necessary. Gradually bring out into full light after this time A little water should be added from time to time if necessary. Should the water need to be changed on no account remove the bulb. Hold it firmly with one hand, and the glass with the other. Gently tilt the glass and allow the water to run out. Fill up slowly with water which is at the room temperature.

Well-shaped bulbs should be purchased for glass culture Ungainly bulbs will often give excellent blooms, but these are best grown in fibre or soil. When ordering state that the bulbs are to be grown in glasses, and the dealer will pick out well-shaped bulbs. The best bulbs should be purchased, and it is well to give a copper or two more for a top-sized bulb for growing in a glass.



Hyacinth glass

FIG. 24

The following are some good named varieties which may be grown in glasses—

Ivanhoe—purplish indigo blue.

Lord Balfour—purplish violet.

L'Innocence—pure white—large bells.

Grandeur a'Merveille—pale bluish—very large spike.

General Pelissier—deep crimson red—does well in glasses or pots.

City of Haarlem—pure yellow.

3. *Bulbs in Pots*

A mixture of soil, as recommended earlier, should be procured, and the addition of a little basic slag is also to be recommended. Drainage should be provided.

Hyacinths Single bulbs should be planted in 4½- to 5-in. pots. Three bulbs will need a 7-in. pot. Four parts of loam, one part of manure, and a little sand will be the proportion. The pots should be filled in September and October. They should then be placed under a greenhouse staging, in a cellar, or even in the garden, and

covered with fresh soil or ashes to a depth of 5 or 6 in. After four or five weeks they may be removed and first placed in a partially shaded position, gradually being exposed to more light. The plants should be carefully watered and special attention should be given to the source of light. Unless the pots are placed in a full light the plants will get long and drawn, and the beauty of the blooms will be spoilt by the fact that the spike will extend to such a length that the compactness of the bells is destroyed.

The named varieties mentioned for glass culture will do for pots. Success with smaller bulbs can be achieved, and both double bedding and miniature hyacinths can be grown in pots. Single hyacinths generally do better indoors than double varieties.

Tulips can be grown in soil in pots. These are not recommended so strongly as hyacinths. Tulips look better in outdoor beds, and many of the forced tulips sold look poor, small, and unreal. If they are to be planted in pots this should be done in October. Tulips planted in beds in the garden should be arranged so that one kind is in each bed. Thus there will be a better chance of all the bulbs in one bed flowering at the same time. A bed of tulips in full bloom present one of the most effective floral displays of early spring.

Daffodils can be well grown in pots. Five bulbs should be placed in a 5-in. pot. The bulbs should be planted early in September.

The following varieties will provide a good selection, and one kind should be planted in each pot.

Emperor—perianth deep primrose—yellow trumpet.

Madam de Graaff—perianth creamy white—primrose trumpet which turns almost white.

Gloria Mundi—clear yellow perianth—orange scarlet cup well open.

Sir Watkin—delicate primrose perianth—fringed yellow crown.

Barii Conspicuus—broad yellow perianth—short cup edged with bright orange scarlet.

Golden Spur—one of the best yellow trumpets.

Poeticus Ornatus—White perianth with red crown—sweet smelling.

There are dozens of other bulbs and tubers which may be grown in pots.

Snowdrops. These do best out-of-doors, and should be planted 4 in. deep; they can be reared in pots.

Scillas or wild hyacinths can be purchased cheaply. A pot is quite interesting. Clumps in a rockery or corner of the garden look well.

Crocuses—a pot of eight or nine crocus plants of one kind look exceedingly beautiful. Buy the best crocuses possible.

Freesias—six bulbs in a 5-in. pot in a mixture of loam, manure, and leaf mould in equal quantities. Should be placed in sun in a cold frame until leaves appear, then need a cool greenhouse or a window in a warm room.

SEASONAL CHANGES IN NATURE

The round of the seasons brings changes in field, garden, and hedgerow. A great deal of useful teaching can be done in drawing the attention of children to these changes. Rightly directed observation will bring details of plant and animal life of surprising interest. Once children are infused with enthusiasm many new facts will be brought to the notice of the teacher.

Notebooks

Each child should possess a notebook in which to enter the observations. The arrangement of these books can be varied to suit the individual tastes of either the child or the teacher. One arrangement will make the book a nature diary pure and simple. A somewhat better method is to divide the book into various sections. Information and observations should be entered under the appropriate section with the date. At the close of the year the child can then review the observations made under one subject.

Suitable sections of the book would be as follows—

(*a*) *Weather*—this would record any notable

features of the weather—severe gales, deep snow-falls, heavy thunderstorms, etc. No attempt should be made to supplant the ordinary daily weather observations by this section

(*b*) *Trees*—facts relating to budding, flowering, fruiting, leaf dropping, etc., would be here recorded.

(*e*) *Insects*—when each insect was first seen, habits of insects, etc.

(*f*) *Wild animals*—habits of rabbits, stoats, etc.

(*g*) *Farm and garden operations*—work in the fields and gardens can be observed weekly and recorded.

By courtesy of *Messrs. Sutton & Sons*

FIG. 25

Springtime

(*c*) *Flowers*—dates on which various flowers were seen in bloom for the first time. In what parts of the district certain flowers were especially fine.

A few well illustrated flower books should be kept for reference by the scholars.

(*d*) *Birds*—dates of arrival and departure of birds, first songs in the year, any peculiar habits of nesting, methods of feeding, bird friendships, all could be recorded in the bird section.

Teaching Children to Keep Diaries

It is extremely helpful if a series of questions are written out and supplied to each child so that he or she may be always able to find some field of observation. Here a word of warning might be given. Should any child develop any special interest in some one idea of Nature study then nothing should be done to diffuse that interest by insisting on general work. The

writer knew a boy who did very valuable observational work extending over a long period on the habits of ants. Another boy made a study of the nesting habits of birds with good effect.

The following set of questions is given as a suggestive list only. The teacher will be able to make one fitting local needs and circumstances.

(*a*) *Weather* For the season of the year was the day too hot?—too cold? Was the rainfall very heavy? Was there a thunderstorm? How near did the lightning flashes appear to be? (Notice that light travels almost instantaneously whilst sound travels at 1,100 ft. per second, or about 1 mile in 5 seconds. Count seconds from the appearance of lightning till the peal of thunder is heard. Divide by five, and this will give the number of miles to the centre of the storm.) Have you noticed anything peculiar in the shape of clouds and direction of the wind?

(*b*) *Trees*. (It is a good idea to apportion various trees to different scholars.)

When is tree quite bare of leaves? What is the general shape of the tree then? (The hours of twilight give a good opportunity for observing the tree silhouette.) When do leaves appear? On which part of the tree are they first seen? Do flowers appear before leaves? How long does it take for the tree to be in full leaf? What are the flowers like? Are there two kinds of flowers? If so, why do you think this is? When do the leaves begin to turn colour? At what date did they begin to fall? Was there frost, considerable rain, or wind before this occurred? What birds appear to like to nest in the tree? Which to sing in it? What insects have you observed in it? What do they appear to do there? Would you think they rendered a service or a disservice to the tree? What changes in size have you perceived in the tree during the year? Have the buds at the tips of shoots grown considerably? Have side shoots developed? Can you see any increase in the thickness of the trunk?

(*c*) *Flowers*. What flowers are now in bloom? What is the prevailing colour of these flowers? In what situations are flowers generally seen? What flowers seem to grow best in marsh?—wood?—meadow? What flowers are visited most frequently by insects? What kind of seed containers do the various flowers form? What provision is made for the scattering of the seed? What curious flower colours have you noticed?

(*d*) *Birds*. What birds are to be seen? What new arrivals have you seen?—any departures? What materials are used for nesting? How do the birds work in building? How are the materials carried? Where is the nest usually built—on the ground, in a hedge, a bank, under a ledge or where? What colour are the eggs? How many are laid in a clutch? How long does it take to hatch the eggs? How are the young fed? How are they taught to fly? What kind of song has the bird? Has it any warning notes? Does it walk or hop? What kind of flight has it? When does it depart if at all? Would you call it a friend or foe of man, and why?

(*e*) *Insects*. Which insects can you see at work? Very carefully study the habits of one. Where is its home? How does it make it? What is its food? Does it lay eggs? How are the young born and reared? What forms does the insect pass through? Where are its haunts? Is it a friend or foe to man?

(*f*) *Wild Animals*. What wild animals are there in your district? Where does each make its home? Study one. When are the young born? Where does the animal get food for itself and its young? When does it go in search of food? How does it evade its enemies? Of what use, if any, is it to man?

(*g*) *The Farm and the Garden*. What operations are being carried out on the farm? What implements are being used? What weather does the farmer like for each operation? Give any special observations on height of crops, weight of crops, difficulty in sowing or harvesting. Watch for any weed which develops quickly and threatens crops. Study pests which attack plants.

What operations are being undertaken in the garden? What is the most favourable weather for these? Watch for similar things as on the farm.

At the end of the year write out a report on crops in farm and garden stating whether it has been a good, bad, or average year for each crop. Then look up the weather for the year and see if you can draw any conclusions.

In connection with this observational work

the teacher may like to know of the competitions that are held annually by the Royal Society for the Protection of Birds. The Bird and Tree Day Scheme was instituted by the Royal Society for the Protection of Birds with a threefold object—

1. To encourage an intelligent interest in and knowledge of Birds and Trees.

2. To provide a new interest in Nature study.

3. To add to the pleasures of country life.

Any teacher who cares to write to the society at 82 Victoria Street, London, S.W.1, will receive particulars of a yearly competition. Teams of nine enter from schools. County shields and individual prizes are awarded.

The most hopeful development of our time has been the change that has come over the name of naturalist The word was often used to describe a man who was interested in stuffed birds, the collector who gave the fullest play to his most selfish instincts and was chiefly concerned to have in his possession something that nobody else had We now understand by the term a man who does not want to have a dead bird on his mantel-piece, but to watch a live bird in a tree, whose interest is not in specimens, but in the free and beautiful and happy life of a living creature The Bird and Tree Competitions will breed a race of such naturalists in every village, and their study of the habits of birds will glow with all the excitement and romance once associated in boys' minds with the killing of birds or the plunder of their nests —*Manchester Guardian*

Collecting Nature Specimens

Competitions can be held in the school for the best collections made of—

(*a*) Flowers.
(*b*) Leaves.
(*c*) Fruits.
(*d*) Seeds.

Many children will like to have a holiday task which involves the collection of such things. Instruction should be given on the best way to press flowers and leaves.

Flower Pressing. (*a*) The simplest method is to get a number of sheets of *white* blotting paper cut to the size of a large book or board which the collector possesses. Each flower, with its accompanying leaves to show the habit of the plant on which the flower grows, should be placed between a double sheet of blotting paper. The remaining sheets of blotting paper should be then placed on top, and finally the book or board should be placed on the blotting paper. Pressure should be made by adding a stack of larger books or by standing flat-irons or large weights on the top board or book. After several days the weight may be removed and the leaves will be found to be pressed.

(*b*) A small press may be made. The materials needed are two pieces of five-ply wood, 12 in. × 8 in. × ⅜ in., and four wing bolts at least 3 in. long. Holes are bored at the corners to take the bolts. The leaves or flowers are arranged between blotting paper or botanical paper, and then placed on one of the boards. The other board is placed on top, the wing nuts are inserted, and the two boards are clamped together.

(*c*) Two wire cake trays and two strong straps can be used. The leaves are again inserted

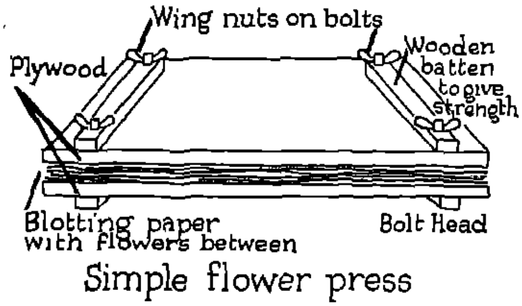


Fig. 26

between blotting paper and then placed on a thick piece of cardboard and arranged on one tray. The other tray is placed on top and then both are strapped together and hung up.

(*d*) Leaves and flowers may be dried in sand. A dish of fine sand should be obtained and the leaves should be placed flat on top of this. More sand should be added so that the leaves are covered. Gentle heat is then applied under the dish. Care must be taken not to apply too much heat.

Mounting. (*a*) Collections of leaves and flowers when pressed may be mounted on sheets of white cardboard with strips of gummed paper, glue, or cotton stitches A box file which will just take the sheets should be used to store them. An index may be written on the inner cover of the file.

(*b*) A book somewhat similar to those used for newspaper cuttings or "scraps" will hold a collection of pressed flowers or leaves. The

construction of the book must be such that the thickness of flowers and leaves will not burst the book binding.

Leaves. Shapes and patterns of leaves can be made in several ways.

(*a*) The pressed leaves may be placed on drawing paper. A blacklead line may be traced round the outline. The leaf can then be removed, the errors of outline corrected, and the finished drawing completed in Indian ink. It is effective if the thicker skin can be indicated by a heavier line.

(*b*) If the leaves are quite dry the shapes of the leaves can be shown on photographic printing paper. Arranged in a printing frame on a piece of sensitive paper the shape can be printed in day or artificial light according to the nature of the paper.

Germinating Seeds. These can be preserved in small test tubes of alcohol. In this way a series of germination experiments can be preserved

Seeds and Fruits. Useful collections of seed pods, fruits, and nature specimens can also be made. Where pressing will destroy the nature of the specimen it may be slowly dried in a water oven. This is an oven placed over a vessel of boiling water. The temperature of the oven does not thus rise above 212° F,—the boiling point of water. Sun-dried specimens keep for a considerable time. Many school collections are quickly spoiled by an accumulation of dust. Where possible, picture frames or glass cases should be used for storage and display purposes. Where this is impossible, specimens should be fastened to cardboard and stored in air-tight and dust-proof boxes.

FIG. 27

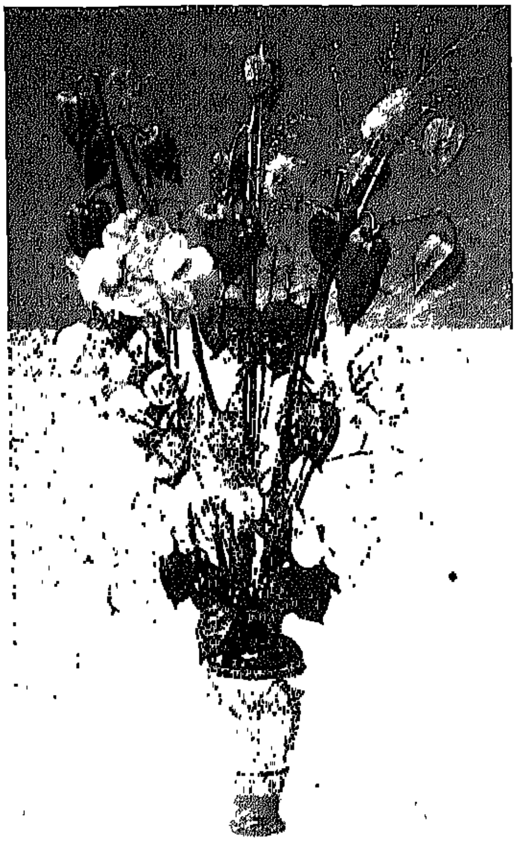
Bowls and Pans for Indoor Plant Growing

All these pots and seed pans are made from unglazed earthenware, and are used for growing seeds, ferns, and bulbs. The rectangular pot can serve as a window box

By courtesy of Messrs Sankey, Ltd., Nottingham

JUNIOR SCHOOL GARDENS

"Primary Schools should have a garden, or a place, however small, where things may grow"—this quotation from the *Report on the Primary*



By courtesy of *Messrs Suttons & Sons*

FIG 28

Vase of Winter Cherry, Honesty, and Ornamental Grasses

The Winter Cherry is used for winter decoration. The plants are easily grown and the brilliant orange pods give colour in the colder months. The Honesty yields shining silvery seeds-pods which blend well with the glowing orange fruits of the Winter Cherry.

School (1931) expresses an ideal to be aimed at, for, where children can tend plants and watch their growth every day, reality is added to the Nature study work. It relates it to life. Therefore, the teacher of Nature study should never be content until the ideal of a Junior School garden of some type is achieved.

The problem which presents itself differs from school to school The notes below are not intended to be exhaustive or to lay down a course of gardening instruction; for the teacher always gains greater pleasure from putting a certain amount of initiative and personal expression into the work

Establishing the Garden

1. *A school which once included Seniors and possessed a School Garden.* Here the Junior Nature study teacher is fortunate, for the school garden is ready to hand. The conduct of a Junior School garden, however, should differ widely from that generally adopted with older children The garden should be laid out with an eye to beauty rather than to the utilitarian purpose of growing vegetables and fruit. In the Junior garden there should not only be flower and vegetable plots on informal lines, but there should also be rockeries full of spring beauty, fruit trees, bird nesting boxes, bird tables, and baths. In a large garden there might even be a wild corner where cultivation is kept to a minimum and where wild life will develop. The idea should be to develop a Nature study laboratory. An ideal—but one for which to strive. A weather observation station can be set up within the garden.

2. *Where Seniors in the School already possess a Garden.* Here the Juniors will not desire to work on the Seniors' garden. Just as the Junior School leads on to the Senior, so the Junior garden should be an introduction to the Senior plots Whilst manual operations will be less difficult, the Juniors will acquire the art of watching and observing the growth of plants, and will learn to recognize seedlings and distinguish them from weeds, and the work of insect and animal life. The Junior garden should be placed between the school and the Senior garden. In one school a long flower border with arches of roses leads from the school to the Senior gardens. The Juniors proudly tend the long flower border.

In one village, the Senior gardens were some distance from the school. The way led past an untidy hedge with a broad rough trackway. The head master conceived the idea of constructing a series of rockeries and wall gardens from the school to the school garden. This work was done by the Juniors. To-day, though the Senior garden is famed as a well-kept garden full of beauty, yet visitors pause longer to look at the brightly coloured rockeries and corners of the Juniors

3. *Where there is no School Garden available.* The problem here is more difficult. Three suggestions can be made—

(*a*) Look round the playground and see if any corner could be dug up and turned into a garden. It may be that a sunny spot can be found that would serve the purpose. A plot of only a few square yards is better than nothing Shrubs are often planted round schools. A sunny shrubbery could be rooted up and used as a garden. Managers and officials will be sympathetic if the case for a school plot is strongly presented.

(*b*) Where it is impossible to establish a plot, a pot garden may be established. The writer recently heard of a woman who, having a yard of but a few square feet, had made a garden by filling butter boxes, drain pipes, and large flower pots with soil. This has also been done in some schools where a sunny corner away from wandering balls and tops can be found. Peas, beans, and other climbing plants can be grown nearest to the wall, and the shorter plants in front. Flowers, of course, take up the major part of such a garden. One school set up a garden like this on the flat roof over a coal-shed, and they even had a garden frame there.

(*c*) Where none of the foregoing suggestions are possible, window boxes can be placed on the sills of the school windows. Directions for planting these are given elsewhere A table should also be provided where a display of

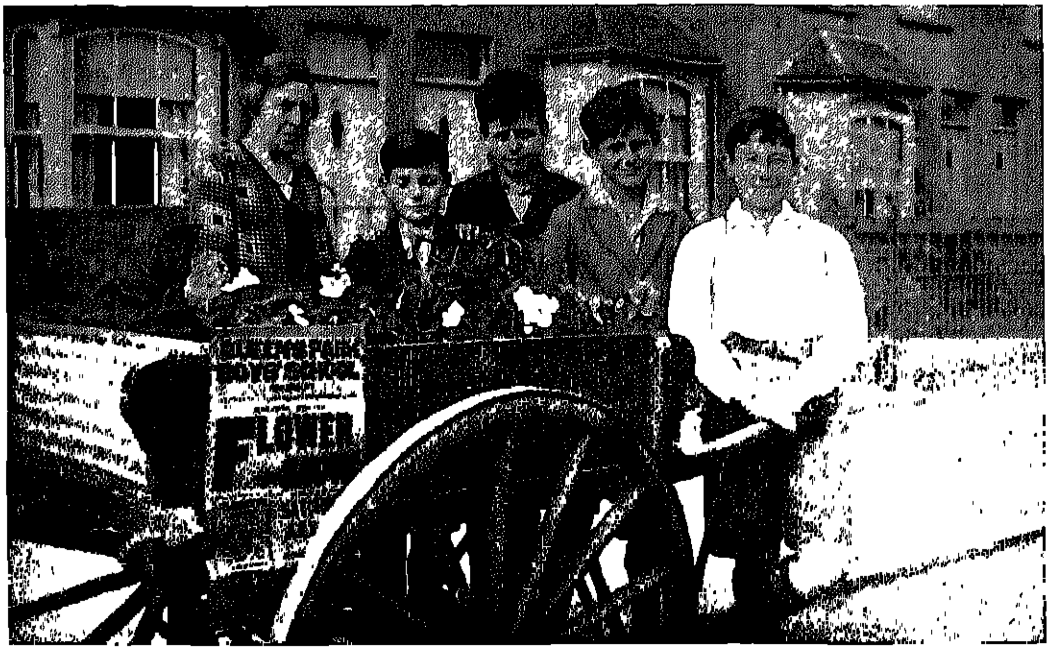


FIG. 29

Collecting Home Grown Exhibits for the School Flower Show

One youthful exhibitor has packed his pots in a Japanese wicker basket to prevent breakage

flowers and seasonal Nature study specimens can be displayed.

Pot Cultivation and the School Flower Show

Here is a further suggestion that has been tried and found to be remarkably successful, whether or not there is a school garden plot

In spring the teacher visits a nurseryman and makes arrangements to buy a number of boxes of bedding plants. By taking a quantity these can be purchased at 1d. each.

Children in school are taught how to pot up one of these seedlings. In due course the plants arrive, each child takes the plants he has ordered and pots them. The plants are then grown and tended by the children at home.

Just before the summer holiday, a school flower show is held. The pot plants, all now gaily blooming, are brought to the show Classes for various flowers in pots are arranged. Only those who have tried this experiment can realize the enthusiasm of the "pot" gardeners

School Flower Shows

Seedlings which have proved successful include antirrhinums, clarkias, tobacco plants, godetia, love-in-a-mist. The smallest boys successfully grew dwarf nasturtiums from seed.

In the autumn the teacher can buy bulbs in bulk and sell them to the children. These are grown in pots at home, and a flower show is held in March. Of course, the teacher must distribute the bulbs so that under proper treatment the flowers will be in bloom when the show is to be held. Show dates can be elastic

Management of the Garden

The garden should be in charge of the Nature study teacher. The tools need not be many in number. Spades and forks should be under full size. A few small hoes, trowels, and hand-forks are necessary. A light barrow and a watering-can will complete the equipment. Valuable lessons can be taught in the preservation of the tools.

Where there is a very large garden, some of the heavy manual work must be done by adult labour This is especially true where the soil is heavy. The teacher must design the garden so that plots are not too wide and are easily worked with trowel and hoe even in wet weather.

In all gardens for Juniors there should be—

(*a*) A flower border with some perennial plants at the back and annuals and biennials in front.

(*b*) A seed bed where biennials and perennials can be raised, and cuttings of roses, etc., can be inserted.

(*c*) A rose corner where ramblers grow.

(*d*) A few plots in which common grasses and a few typical vegetables can be cultivated, e.g. one row of wheat, one of barley, one of oats, a line of carrots, a few onions, half a dozen potatoes.

(*e*) A few climbing plants—beans, peas, etc.

(*f*) Spaces in the flower border for bulbs.

(*g*) A corner for watching propagation by runners, underground stems, etc.

(*h*) A salad corner where lettuce, radishes, and other such plants can be grown.

(*i*) A few fruit bushes—gooseberry, black currant and red currant.

(*j*) One standard apple tree.

This may seem a considerable number of plants, but it is surprising what can be grown in a small space, and with these practically all the material for a year's work in Nature Study will be at hand.

Suggestions for Work

1st year. Flower gardening (including annuals and biennials), bulbs, ornamental grasses, and sweet peas.

2nd year. Flower gardening (annuals, biennials, and perennials), division of roots, and cuttings.

3rd year Flower gardening as in previous year; plots for barley, wheat and oats, salads, etc., lettuce (cos and cabbage), radishes, marrow, kidney beans, mustard and cress in boxes.

4th year. Flower gardening as before, vegetable growing—some rows of carrots, parsnips, onions, beetroot, early and late potatoes, garden peas, dwarf beans; obtaining seeds from onions and beet saved from previous year.

PLANT LIFE

FORMER sections have dealt with the many ways in which natural phenomena can be observed. This section will describe the various parts of a plant, explain the functions of each of these parts, and suggest how these facts may be used in Nature study lessons. Many older Juniors enjoy making simple experiments.

General Survey

From the germinating *seed* emerges first a *root* (radicle) and a *growing shoot*. The plant is anchored in the ground by means of the root, and receives some of its nourishment from food extracted from the soil. Through the stem food is carried upward to *leaves* and other parts of the plant above the soil.

Leaves assist in feeding the plant by building up food from the air and water in presence of sunlight, and by "breathing."

Finally, *flowers* develop in most plants. These have various parts which lead to the creation of live *seeds*. These *seeds* in due course ripen and are scattered by various means In turn some of them germinate and give rise to a *new generation* of plants. Thus the cycle of life continues.

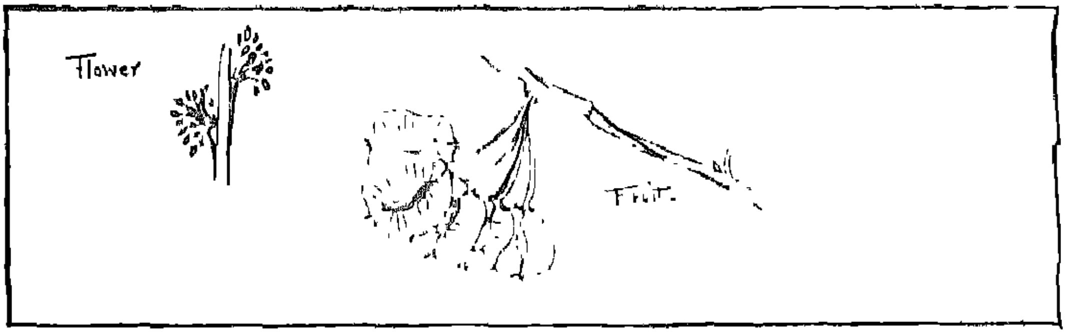


FIG. 30

Flowers and Fruit of the Elm Tree

THE ROOT

In the course of experiments on germination it will be seen that the root emerges first from the seed. There are many questions that need to be answered in connection with the structure and work of roots.

The following facts about the way in which the root of a broad bean grows have already been discussed: the teacher should repeat the experiments dealing with these which will be found in the previous chapter on Germination—

1. The root grows vertically downward, owing to the force of gravity.

2. The root, however, will resist this force when in need of moisture, and will alter its course in order to reach a supply.

3. The root will turn from its perpendicular course if certain obstructions are in the way of its growing tip

4. The root appears to grow most rapidly just behind the tip From this last fact it can be realized that the youngest part of the root is that immediately behind the growing tip

Experiments

Experiment 1. Grow a broad bean seed in an observation box and revise the facts stated above.

Experiment 2 Sow mustard and wheat seeds on flannel Observe the tiny rootlets which develop from the main root just behind the root tip.

Experiment 3 Sow some mustard seeds in soil in a 4-in pot. When the seedlings are about

1 in. high carefully shake out the soil and separate the seedlings. Notice soil clinging round the roots of each seedling. Lower one of the seedlings carefully into a basin of water and shake gently. The particles of soil will fall off, revealing the tiny rootlets.

Just behind the growing tip *Root Hairs* form and grow out from the main root. Careful observation in a germinating box or jar will show that the root hairs soon perish as the stem becomes older and *new* root hairs develop on the younger parts of the growing stem

Experiment 4. Place 10 wheat or mustard seeds on a piece of porous tile or pot, and stand

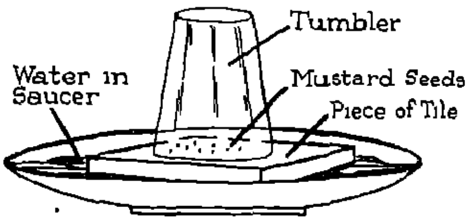


FIG. 31

Experiment to Show Development of Root Hairs

in a saucer. Pour water into the saucer until it is almost on a level with the top of the tile. Place a tumbler over the tile. Germination will begin. Watch carefully for this appearance of the root hairs which will develop very markedly.

Work of Roots

From observations made in the garden, hedgerow, and field it is clear that one of the things which a root does is to *anchor* the plant, tree, or shrub in the soil. Various plants should be examined and pulled from the ground. Thus the differences in roots will be seen as well as the method of rooting.

The root system increases as the plant gets bigger, and not only one root but many side roots assist anchorage. The value of the roots in this way can be especially noticed in trees. As the tree increases in size large anchorage roots develop near the surface of the soil. In many cases they come out above the soil. When they do this they lose the true root function.

Observation of tall pine trees on the mountain slopes in the forests of Scotland and Switzerland has shown that the roots must go down a considerable depth into the ground. A huge tree over 100 ft. high often appears to be perched on a rock. The winds of autumn and winter fail to dislodge it or move it from its perpendicular position.

Some trees do not possess such deep roots as others. After a blizzard or gale it is found that elm trees have suffered more than most trees. Not only is the timber of the elm brittle but the roots are developed on the surface of the ground only.

Food. The second function of roots is to obtain some of the plant's food. The root absorbs this food from the soil in which the plant is growing. Experiments can be performed to show that there must be plant food in the soil.

Experiment 5 Grow beans in three pots In one put sawdust. In the second place clean sand which has been first washed in several changes of clean water. Ordinary garden soil should be put in the third. Notice how, after getting to a certain stage of maturity, the beans in the first two pots die. That sowed in the third continues to flourish and grow. (Where used in connection with a course of lessons in schools it will be necessary to start this experiment three or four weeks before the lesson is to be taken. Of course, the children will observe the progress of growth throughout this time.) The teacher may notice another experiment which shows clearly that the plant has absorbed something from the soil, though this experiment is not suitable for Juniors.

Experiment 5*a*. Obtain two broad bean seeds of the same weight. Allow one to grow in a 5 in. pot until it is almost full-grown. Remove it from the soil Chop it up into small pieces and place these in a crucible Heat gently at first and then more strongly. Water will first be driven off. Continue heating, charring will take place and then burning. The black colour of charcoal will be seen. Heat more, the charcoal will all combine with the air to make carbon dioxide, and finally a grey ash only will be left. This grey ash is mineral matter. When cool weigh this mineral matter.

Now heat the other bean seed until only ash

is left in this case. Weigh the ash. It will be found that there is more mineral matter in the residue of the grown bean than in that of the other. Where did the extra mineral matter come from? *It must have come from the soil.*

Experiment 5b. Comparisons between beans grown in water only and those grown in water

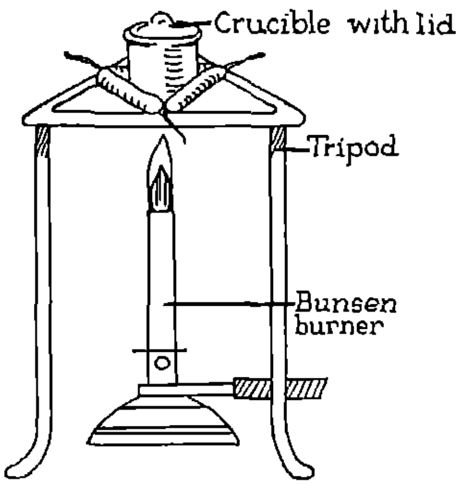


FIG. 32

Experiment to Prove Presence of Mineral Matter Extracted from Soil

in which a chemical solution containing mineral salts has been placed can be made. A bean plant will develop leaves, flowers, and often pods of seeds if grown in the following solution—

Potassium nitrate	1 grm.
Calcium sulphate	½ ..
Magnesium sulphate	½ ..
Calcium phosphate	½ ..
Sodium chloride	½ ..
Water 1,000 c cms	

Notice if the seed is germinated in a bottle of this then-
(*a*) The bottle must be covered to exclude light.
(*b*) Air must be bubbled through the solution occasionally.
(*c*) Water must be added as the solution evaporates
(*d*) The plant must grow in a good light

Soluble Food. All food which the plant absorbs from the soil must be soluble. The teacher should show the difference between soluble and insoluble substances. Experiments on the solubility of salt and sand will show this. A mixture of salt and sand stirred in water will leave the sand as a sediment, the salt having dissolved. Filtration will remove the sand. *Roots* take up soluble food, and this can be shown as follows.

Experiment 6. Prepare two jars so that one contains water coloured with red ink and the other water with carmine rubbed in. Place a broad bean or other seedling in each. Leave for several hours. Remove the plants, wash them carefully, and cut across the stems with a knife. Notice that the red ink has gone up into the stem but the carmine has not. Carmine is *insoluble* in water, red ink is red because of a dye which is *dissolved* in it.

Soil

Little needs to be taught to children in a Junior School about the chemistry of the soil, but the following facts might be usefully given—

(*a*) Soil is made by the breaking up of rocks by the weather. Frost causes water to freeze. Just as ice breaks water pipes because the ice is larger in volume than the water from which it is made, so the ice in rock crevices splits the rocks. Change from hot sunshine of summer and intense cold of winter also assists in the breaking up of rocks.

(*b*) Examination of a quarry face will show that the soil can be divided into three distinct layers—

1. The top soil, which is usually dark in

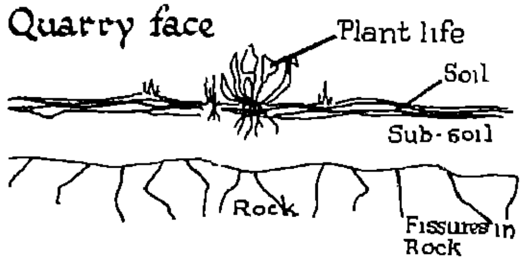


FIG 33

colour. This colour is caused by the presence of decayed leaves and other parts of plants.

2. The sub-soil, which is lighter in colour.

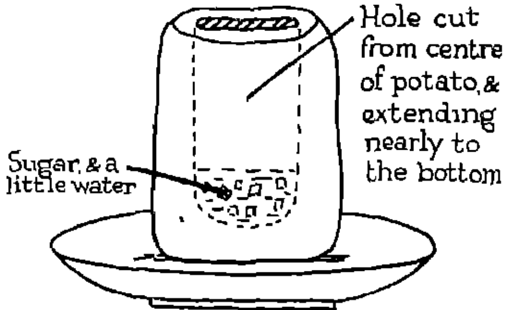
3. The rocks splintering and breaking up below.

(*c*) Many wonderful creatures, extremely small, are at work manufacturing plant food.

This they make from manure, and the nitrogen in the air, and in other ways

Experiment 7. Stir round some soil in a small jar containing distilled water. Filter the water. Evaporate some of the water and show there is a residue. This proves that the soil contains substances that will dissolve in water.

How does the food enter the root? This question should be dealt with only simply. It will be sufficient to say that the liquid passes through the tiny root hairs into the main root. A very



Potato with slice cut from top and bottom standing in a saucer of water

FIG. 34

interesting experiment shows something of the way in which this is done.

Experiment 8. Cut a slice from the bottom and top of a large potato so that it can be made to stand up. From the lower end pare off the skin to a depth of about ½ in. At the top scoop out a hole. Stand the potato in a saucer of water. Put sugar in the hole with a tiny drop of water to dissolve it. Leave for some hours It will be found that water from the saucer passes through to the hole, and gradually the hole fills up and will ultimately overflow. In something the same way liquid passes into the roots. It must be said, however, that the whole theory of *osmosis* or the interchange of liquids through a living membrane is too difficult for young children.

Note. Some liquid passes the other way from within the plant outward. The teacher may like to prove that this happens by the following two experiments.

Experiment 8*a*. Obtain a smooth piece of limestone Allow seeds to germinate on top of it. The roots will make small marks on the limestone (marble) caused by the acid given off (in solution) from the roots.

Experiment 8*b*. Germinate seeds in a saucer on flannel. Place litmus papers on seeds and notice that the papers become red, showing the presence of acids.

Various Kinds of Roots

It is now necessary to examine briefly the different types of root, examples of which can be obtained from the garden

Tap Root In the broad bean and other dicotyledons observation has shown that—

(*a*) The radicle grows vertically downward

(*b*) Root-hairs which absorb food from the soil develop just behind the growing part of the root.

(*c*) Root hairs live but a short time, new ones forming on the newer part of the root.

(*d*) Secondary roots grow out from the radicle. These also develop root hairs.

Notice that this type of root is generally, though not always, found in dicotyledons

Fibrous Roots. When growing maize, wheat, and other cereals it was seen that—

(*a*) The radicle developed but soon died, and did not, therefore, remain as the chief root of the plant.

(*b*) Thin threadlike roots developed from the base of the plant itself. They were all of the same thickness, and none was more important in the root system than any other. These roots are known as Fibrous Roots.

A special name is given to any roots which do not develop from the radicle or branches of the radicle. This name is *adventitious*, a word which means "coming from without," indicating that the roots have developed in an unusual or unnatural position. The teacher should obtain specimens of both tap roots and fibrous roots Good examples of fibrous roots can be found in those of the grasses and the strawberry plant In these cases the adventitious roots grow from the base of the stem.

The common groundsel plant may be examined. This has fibrous roots, but instead of these developing from the stem base they grow

from the top portion of the root. Hyacinths grown in bowls will furnish splendid examples of fibrous roots growing from the stem of the plant.

Cuttings. The children may be interested to know that adventitious roots develop on "cuttings" taken from plants. Rose shoots pulled from a branch so as to include some of the old bark when placed in a deep trench with a sprinkling of sand and made firm develop adventitious roots round the break. Growth begins and rose trees can be obtained in this

FIG. 35
A Rose Cutting

way. If rose cuttings are placed in a glass jar of water with some pieces of charcoal they can often be induced to make roots. Other plants which are frequently treated in a similar way are geraniums, pansies, and willows. Pansy cuttings should be placed under a glass jar in soil.

Roots that Store Food. Many tap roots remain quite slender, but there is a large number of plants in which the tap root begins to swell and thicken because food manufactured by the leaves and food abstracted by the root hairs is being stored there. The children should be able to furnish examples of such roots, and the teacher should obtain specimens of the chief types

(*a*) The long, coloured, conical root of the carrot is well known. Notice that there are also varieties of carrots in which stump-shaped roots are found.

(*b*) The parsnip with its long conical root. Enormously long roots can be obtained by special preparation. A deep hole 4 or 5 ft. deep is made with a crow-bar. This is filled with fine soil, and a seed is sown near the top.

(*c*) The turnip and swede have almost round, swollen tap roots. Some part of the plant stem seems to swell in addition.

(*d*) The dandelion has a swollen tap root. In this connection notice how difficult it is to remove the whole of the root from the ground, and how it seems almost impossible to kill this weed.

(*e*) Radishes can be grown in pots and the roots examined at intervals—both round and long varieties are cultivated.

Why does the plant store food in the roots? This question may arise in the minds of the children. Remember that the seed is Nature's method of continuing plant life even in spite of cold winters. The swollen tap root is another method. Certain plants do not perform the cycle of (*a*) seed, (*b*) plant, (*c*) flowers, (*d*) seed in one year. *Annuals* do. Some plants take *two* years to come to flower, fruit, and seed. Such plants are called *Biennials.* During the first season the seed germinates, the plant develops, and then stores food within the root. In the second year flowers appear, and finally seed is produced. Frequently the plant dies after this. Examples of biennials are carrots, parsnips, and swedes. Others will be suggested, or names can be obtained from a seedsman's catalogue.

Roots as Food. Many of the swollen tap roots are used as food for both man and animal. The teacher can discuss this matter with the children. In most cases the food supply is present in the form of *Starch.* On the other hand, some roots, such as the *Sugar Beet,* store up supplies of sugar. A large proportion of the world's sugar is obtained now from this swollen root.

Other interesting forms of swollen roots are to be found in the dahlia and lesser celandine. Here little bunches of swollen roots can be observed.

Climbing Roots The ivy develops a number of adventitious roots from its stem. These roots grow away from the light. They are useful in that they hold the main stem of the plant to the wall. Various creepers might be examined in order to find further examples.

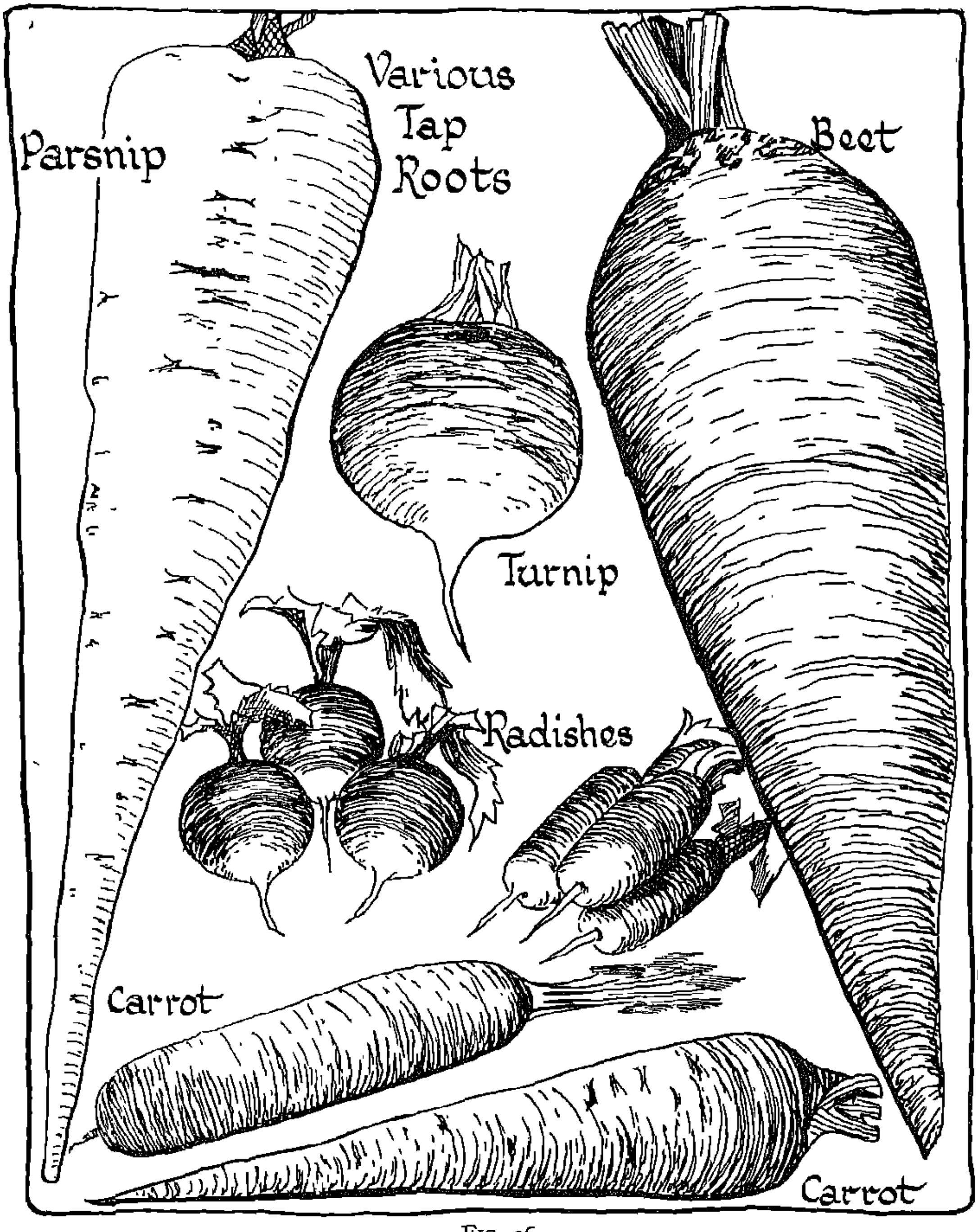


FIG. 36

Roots that Store Food

Several of such roots should be left in the school garden till the second year when they will bloom and form seed. An onion can be similarly treated

Other Interesting Roots. The following details of other roots might be noticed—

1. As *maize* grows adventitious roots develop about 6 in. to a foot above the ground, and grow down at an angle into the soil. Thus these form a support.

2. Orchids develop "stay" roots which perform an almost similar function. In addition some roots are feeding roots.

3. Pond weeds frequently have no real roots in the sense that they do not go down into the soil. All the nourishment the roots obtain is from the water. Air sacs are present in some and help to keep the plant afloat.

STEMS

A considerable number of experiments has been described in reference to the root of the plant. The nature of the stem must now be examined.

An examination of a plant and a recapitulation of the work already outlined will show that—

1. The stem is the part of the plant that grows above the soil.

2. The stem develops from the plumule or growing shoot.

3. The stem is generally green or in older plants brown, whilst the root is white.

4. The stem bears on it *buds, leaves, flowers,* and *fruits*; the root has none of these (this distinction is most important).

5. The stem must carry the leaves, flowers, etc., up into the air, and be strong enough to bear the weight of these and resist the winds and storms that may beset it.

6. The stem must carry food from the roots to the leaves, etc.; in order to do this it must be waterproof.

Cross Section of Stems. Provide the children with a number of stems, a knife, and a cutting board. (Millboards or old cardboard will be suitable.)

Let them cut across the stems in turn and make drawings of each type.

Suitable plants for this exercise are—

(*a*) Deadnettle, wallflower, mint, sage. These have angular stems, some being square in section, some five-ribbed, etc. Later the relation of the shape of the stem to the formation of leaves can be studied.

(*b*) Rose and oak seedlings—Round stems.

(*c*) Sweet pea are flat stalks.

Texture. Stems vary in texture. Some are soft or *herbaceous*, whilst others are *woody*. Get the children to examine a number of stems and place them in one of these classes. Are there any plants which possess both kinds of stems? On which parts of the plants are each found?

Type of Stem: Method of Growth

This can be discovered by observation.

1. If the stem grows straight up it is said to be *erect*. This is quite a common type, and is to be found in trees, grasses, and herbaceous plants. These will be examined later in order to study the details of their texture.

2. If the stem is not strong enough to support itself but uses some prop then it is called a *Climbing Stem*.

3. Creeping stems, from the nodes on which new plants develop.

4. Underground stems, which generally store food, and from buds on which new plants develop.

Plants with Climbing Stems

There are many types of climbing stems, and the teacher should procure examples of each, and where possible show the children the plants actually growing.

Scramblers

The common blackberry cannot be said to climb, it sprawls or scrambles over the other plants and bushes growing in the hedgerow. Its growing stem is very persistent in spite of the tenderness of the leaves and shoot tips. Examine the prickles on the blackberry. Which way do the hooks point? Compare the prickles with those on rose trees. Give a sideways push

to one of them. Notice that it easily breaks off, and that it has no woody centre. An interesting experiment can be carried out with a spring balance, some thread, and a bramble cutting. Tie the thread to a prickle, and the other end to the spring balance. Pull along the branch and find what pull is registered on the balance scale before breakage occurs. Repeat but pull at right angles to the shoot. Much more force is required in the direction along the stem before the prickle breaks. This is, of course, as it should be. Goosegrass is another example of a scrambler.

Twining Stems

Twining stems are those which actually wind round and round a support. The path followed by such a stem is known as a *spiral.* The path may be in the same direction as that followed by the hands of a clock, when it is termed *left-handed*. The hop, honeysuckle, and black bryony make left-handed turns. When the stems move against the direction of the hands of a clock they are said to have a *right-handed* movement. Runner bean and convolvulus stems move in this way.

A great deal of observational work on twining stems was done by the celebrated scientist Charles Darwin, and this is recorded in his book *Climbing Plants*. Where there is an opportunity for growing plants either in the garden or in large 12 in. pots, some of the experiments he carried out can be copied. Of course, adapted for the Junior School they would be much simpler.

Experiments. Here are some suggestions of observations that may be made—

Time of experiments—Summer. One seed in each pot.

Plants observed—hop, convolvulus; runner bean.

Sow seeds some weeks in advance.

(i) Stand pot at centre of a circle marked on soil. Give the plant no support and watch what happens to the growing tip. Observations should be taken during an afternoon session from 2 till 4.30 p.m., and the position of the short tip with relation to the circle should be marked. This will give some idea of the time taken to make one revolution.

(ii) If Experiment (i) can be conducted on two days when the weather differs in temperature it will be found that the rate of revolution is slower at a lower temperature.

(iii) Find whether a stem turns more readily round a thin or a thick support. In general a thin support is favoured. With time and a number of plants upon which to experiment the actual limit of thickness could be discovered.

(iv) Allow a plant to grow round a thin support and then remove the support. What changes take place in the shape of the stem? Notice the stem endeavours first to straighten itself and then the tip revolves in an endeavour to find other support.

(v) Notice that the lower part of the plant does not revolve.

Tendrils

Some stems climb by developing wonderful tendrils which cling as with twining fingers to any suitable support. Those who have grown sweet peas will have watched the magic of the clutching tendrils. (See also White Bryony, Fig. 37.)

The tendrils have various shapes, and are modifications of other plant forms. In some plants the tendrils are modified *leaves*, but in the vine and virginia creeper and in several other plants they are modified branches.

Observations can be made on the habits of the tendrils—

(i) Stroke a straight tendril gently with a smooth pencil. Notice how after a very few minutes the tendril begins to clasp the pencil. Compare this with what happens as the plant sways in the wind. Children will be fascinated by the almost intelligent efforts of tendrils to wrap themselves round a stick used to stroke them.

(ii) Observation of tendrils will show that they twist round and round and often twist at one end in the opposite direction to that of the other. Compare the use of this with a doubly wound spring. Though swayed by the wind the tendril will stretch but not break. Notice that tendrils which find no support coil in only *one* direction.

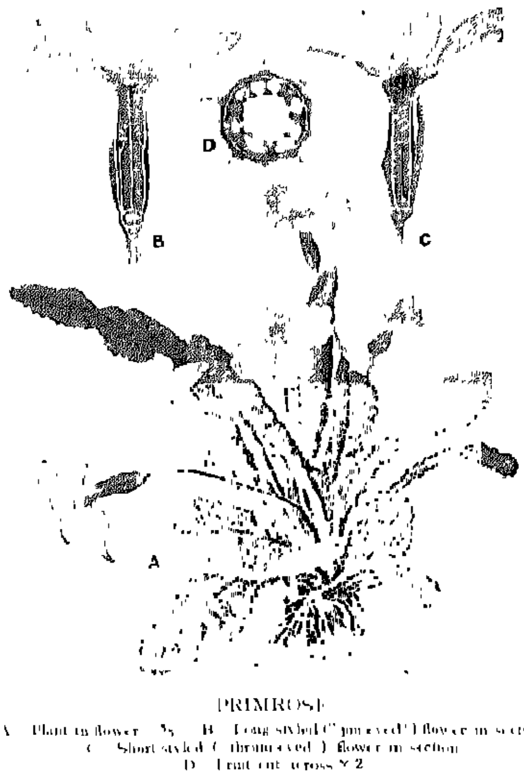
It is interesting to notice that the *Virginia*

TUFTED VETCH

A. Part of flowering shoot × ½   B. Sprig with fruit × ½   C. Flower × 2½
D. Flower in section × 2½   E. Seed × 1½

WHITE BRYONY

A. Portion of flowering stem of male plant × ⅘
B. Same of female plant × ⅘   C. Clusters of ripe fruits × ½
D. Male flower in section × 3   E. Female flower in section × 3



PRIMROSE

A. Plant in flower × ⅗   B. Long-styled ("pin-eyed") flower in section
C. Short-styled ("thrum-eyed") flower in section
D. Fruit cut across × 2

PLATE I

By courtesy of   BRITISH MUSEUM (NATURAL HISTORY)

BRITISH FLOWERING PLANTS

Creeper has a type of tendril which does not cling but which secretes a kind of cement. This cement anchors the tendril to the support. Notice the colour of the tendrils of the virginia creeper and watch what happens to any which can find no support.

Climbing by Leaf Stems

Some plants climb by using the leaf stems. Amongst plants that are in this class and which can be easily observed may be mentioned (1) the nasturtium, (2) the canary creeper. A wall facing south can be sown with seeds of these. Strings can be supplied for the plants to climb.

Creeping Stems

As a contrast to these climbing stems some of the reproductive creeping stems may be studied. The silver weed and ground ivy can be studied anywhere in the summer as both are common weeds. The strawberry also comes in this class.

Underground Stems

In defining stems it was stated that roots grew *below* the ground and stems above. This is a general rule, but like every rule there are exceptions to it. Underground stems can easily be differentiated from roots. Roots have no leaves, buds, or flowers.

Underground stems are quite common in herbaceous plants that die down in the autumn and spring up again in the following spring. Such stems which run horizontally or at an angle underground are often called *Rhizomes*. Examples of plants bearing such stems which may be studied are—

(*a*) Solomon's Seal, a plant which grows wild but which may quite easily be transplanted to a school garden border and there observed.

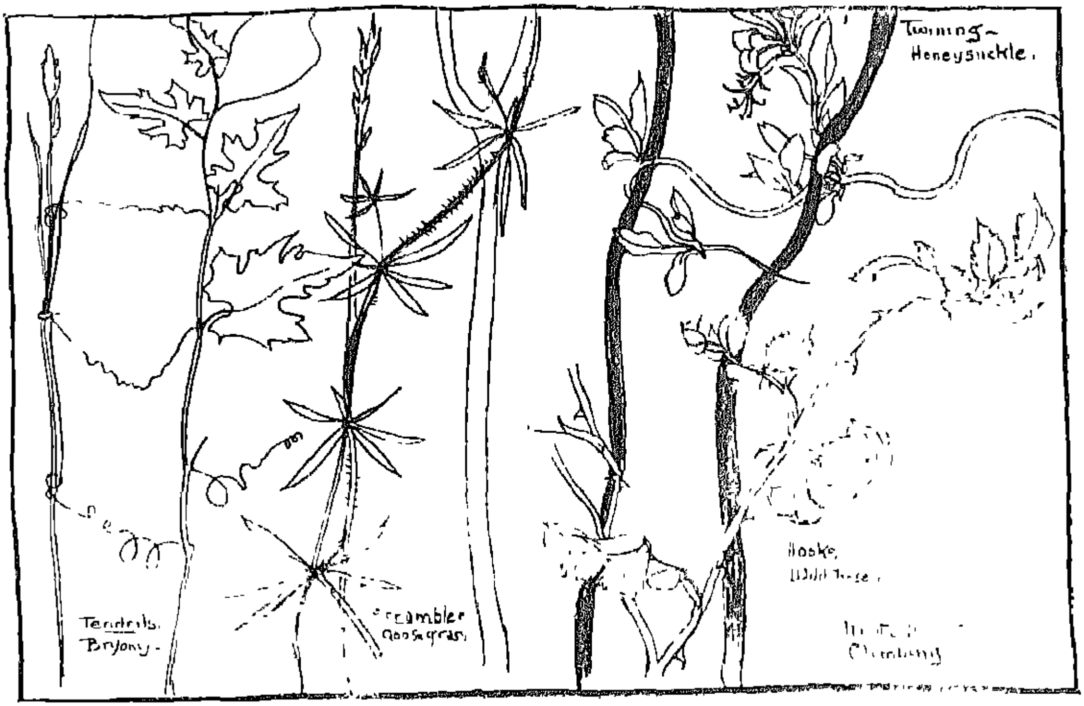


FIG 37

Climbing Plants

(*b*) The Iris. (Cultivate in flower border).

(*c*) The Wood Anemone—plants can be found in woods in early spring.

(*d*) The Coltsfoot is found on waste farm lands. In appearance the flower is something like a dandelion flower but smaller. Here the underground root is not a true rhizome as the thickened stems are vertical.

(*e*) Couch grass provides an interesting study of underground stems. Gardeners and farmers alike know how rapidly this pernicious grass spreads.

Tubers are swollen parts of underground stems. The potato and the Jerusalem artichoke are two plants that develop tubers. The potato is such a commonly used vegetable that a lesson might well be devoted to this plant alone.

The Potato

In order to give the children a complete idea of the way in which a tuber forms, observation of three stages of growth will be necessary (*a*) the growing potato plant as it approaches maturity; (*b*) the potato tuber as it is taken from the plant; (*c*) the tuber after it has started to grow. All these can be seen at the same time if the lesson is given in September. Potatoes of the late varieties will be still growing in the school plot, and a few tubers can be sprouted in a damp dark cellar.

Examination of a Potato. Observe the shape and describe this. Notice that various varieties have different shapes—*Arran Comrade* is a perfectly round potato, the *Duke of York* is long in shape. The pale brown of the skin is general, though there are a few potatoes which have other colours. *King Edward* is blotched with pink, and can be easily recognized though *K of K* is somewhat similar.

The eyes of a potato can be seen and the bud in the centre of each can be described. Get a number of spent match stalks and push one in to each eye. Tie coloured wool on the match stalk nearest one end and wind the wool from eye to eye until the other end of the potato is reached. Notice the way in which the eyes are arranged.

Peel the potato. How thin can you pare it and take all the skin off? What is the difference between the inside of the skin and the outside? It is clear from the appearance of the inside of the potato that it contains a great deal of *water*. Grate the inside of a potato, stir it in water. Notice that it is insoluble. Tested with iodine solution it is found to be made of *starch*. Here again then is a *food* store for the plant. Compare this with the previous work on *tap roots* and *seedlings*. Point out that starch to be useful to a plant must be converted into sugar (again compare with man).

Observations on a Sprouting Potato. When a potato has sprouted in the dark, there is a long white stem developed from each eye Delicate and unnatural, such growths appear to have no strength Children will probably have seen numerous growths such as these on potatoes kept in sacks through the winter These are rubbed off if the potatoes are required for food.

If after growth has commenced the potatoes are brought out into the light and placed in a single layer on a tray, then the shoot develops strongly and very soon young leaves develop and the beginning of a plant is seen.

Both methods of sprouting should be shown.

Observations on a Potato Plant Growing in the Garden. Show children that the potatoes are grown in rows or drills with sufficient space between them to enable gardeners to work the soil. Point out the ridge of soil on each side of the potatoes. Carefully take the soil away from a potato plant. Find a potato and take pains not to sever it from the plant. Show that the potato is attached to the plant by a stem growing out from the stalk *below* the ground. Point out buds on this stem and explain that the potato is a swelling at the *end* of a stem. Pull or dig up the plant and find the real potato *roots*.

Growing Potatoes. There are two methods of growing potatoes. (1) *From seed.* Potato plants flower. In many cases the flowers drop off It seems almost as if the plant knows there is a method of reproduction other than from seeds. Still some varieties develop seed boxes—known sometimes as potato apples, which are poisonous—and seeds from these will grow. The first year's tubers are very tiny, and it takes many years to get potatoes fit for sale in this way. Still *all new varieties* are obtained from seed,

and potato seed may be sown in the school garden and results examined.

2. Each *eye* on a potato is a growing bud, and from each it is possible for a potato plant to develop. Even with only a little of the white flesh attached a fair-sized plant can be grown. It is usual, however, for gardeners to select potatoes of about 2 oz. in weight, to let these "shoot" in trays, and then to plant them in rows. Of course, the name "seed" potatoes is not strictly correct, though it is one which is often applied to the "sets."

History. The teacher may like to complete the work by giving a few historical details—

The potato, a native of South America, was introduced by the Spaniards from Peru to Europe at the beginning of the sixteenth century; brought to Britain by Sir Walter Raleigh in 1585.

How Food Travels in Stems

This question can now be examined

Experiment 1. Grow a kidney bean plant in a flower pot in preparation for this. When about 2 ft. high cut the plant off 1 ft. from the ground. Does anything happen at the cut surface? What does the liquid appear to be? Look carefully and see what portion of the stem is bleeding.

Experiment 2. Stand a white flower such as a narcissus in red ink. After an hour or so red markings will appear in the flower. Cut across the stem and notice where the red-ink markings can be seen.

Experiment 3 Place the leaf of a cabbage in red ink and repeat above experiments. This time scrape away the skin until indications of red ink are seen.

Experiment 4. Select a laurel spray with about six leaves on it. Cut off the bark on the stalk at the base and scrape away any soft substance underneath with a pen knife. Place the spray in water so that the peeled portion only is in the water. The leaves do not wither. This proves that the water must *ascend* to the leaves through the wood. If this is repeated using red ink the actual path can be seen.

It is thus seen that *water*, with the dissolved mineral matter from the soil, travels up the stem of a plant along the woody part.

In discussing roots it was found that cuttings placed in sandy soil or in water develop roots from the *bast* layer. It is in this layer that the food manufactured by the leaves travels *down* the stem.

Annual Growth of a Stem

Some interesting work on this subject can be done in winter, by observations of twigs of trees Teachers will find that drawings of such twigs made by children will be much more detailed and true to Nature after such studies. Suitable twigs may be obtained from *horse chestnut* or *beech* trees.

Observe first the terminal bud Remove the bud scales and notice the markings left on the stems. Tell the children that the bud would have developed into the new stem in the next growing season (they can observe this in later work). Now ask the children to find scars of this nature lower down the twig. This will lead to the fact that the distance between the top bud and the scar is the part that has grown in the summer just past, i.e. it represents one year's growth.

Now find the second set of scars, and thus determine the length of wood *two* years old. Mark out older wood in a similar way.

Cut across the stem at each set of scars and notice that at the base of the terminal bud there is only pith. That one layer of wood is seen for each year of age at the other point is clearly seen.

Obtain a section of a tree trunk and show the annual rings. The explanation of the appearance of such rings can be given to the children as follows.

In woody stems inside the bark is a layer of *bast*. Next to this is a layer known as the *cambium* layer, and inside this is the *wood*. The cambium layer as it is fed splits up on one side to bast and on the other side to wood During spring and summer growth is very abundant owing to the large amount of food supplied from leaf and root As the temperature becomes lower and the sunny days more infrequent growth becomes slower in autumn, stopping altogether in winter. The wood made in the quick-growing season is of more open texture than that of autumn. The wood of autumn is of closer and thicker texture. When growth

commences again in spring the wood is again of an open texture. Thus it is easy to pick out the various layers of differently textured wood, and to see how annual rings are formed. In the Natural History Museum at South Kensington there is a section of a huge tree, and the date on which each ring was formed is indicated together with interesting historical happenings in those years. The teacher should obtain various tree sections and let the children find the age of each. Was the tree older than the child who examines the section?—older than his parents?

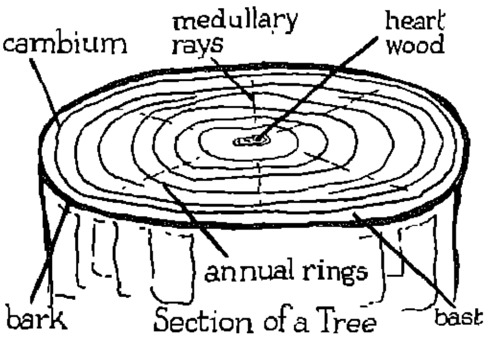


FIG. 38
Section of Tree Trunk

Timber Trees

The wood of large trees is used for timber. There are still some questions to be answered about the trunks or large stems of trees.

1. *What is the Bark?* In a young plant the outer skin is alive, and has breathing holes (stomata) In the large tree the stem is old and possesses a hard, tough skin of quite a different kind. This is known as *bark*. The outer part of bark is *dead*. Thus, if the tree continues to increase in size and the bark is dead there must come a time when the outer coat will no longer fit the growing tree. It then splits and new bark forms underneath The living part of the bark is really *cork*. This cork is a protection to the living bast on its inner side.

Observations on the barks of trees may be made and the following points may be noticed—

(i) Has the tree a thick or a thin bark?

(ii) Is the bark ribbed or smooth?

(iii) Does the bark appear to drop off at a definite time of the year?

(iv) Is the bark made of several layers? (Look at the beech tree.)

(v) Does a tree exposed to sunlight have a thick bark or a thin one? If possible compare the bark of an oak tree growing in the middle of a wood with that of one in the middle of a field.

Remember that the bark protects the tree from—

(*a*) fierce sunlight and so prevents evaporation,

(*b*) frost—(Is one reason why baby shoots are often killed by the frost the fact they have no real bark?)

2 *Medullary Rays.* On examination of the cross-section of a tree, rays radiating across the wood can be seen These rays serve three purposes—

(i) They convey water and food across the rings

(ii) They store starch and in some cases oil.

(iii) They strengthen the tree, acting as horizontal "ties."

3 *Sap Wood and Heart Wood.* Obtain a plank from a builder's yard. Notice that planks are cut *down* the length of the trunk. From observation of such a plank notice that the *fibres* of the stem are vertical. Where the wood is taken from the central part of the tree it will be found to be firm and hard. Near the edge of the plank the wood seems softer, and on a newly sawn plank wetter than that in the centre Wood from near the centre of a tree is known as *Heart Wood*, and that from the outer part *Sap Wood.* The harder, drier heart wood is more suitable for building and carpentry, the sap wood is generally rejected.

4. *Knots* are often seen in planks. If one is examined it will be noticed that the grain in the plank is broken by the knot. Ordinary wood fibres in the tree run perpendicularly up the trunk. The knot is really a cross-section of a branch which grew out from the trunk at that point Therefore it should be expected that the fibres in the knot would be at an angle to the main tree fibres. The tree itself continued to grow after the side branch began to grow, and the beginnings of the branch were surrounded by vertical tree fibres. It is possible to trace

back to the beginning of a knot. No knot could start from the centre of a tree. Would a knot still exist if the branch were broken off early in its life history? In such a case would the knot be carried to the extreme outer edge of the tree? Let the children discuss these questions.

LEAVES

Before proceeding further with the study of the growth of stems and the unfolding of buds it is necessary to pay some attention to the form, nature, and work of foliage leaves.

The important work that leaves render the plant has already been discussed with the experiments on germination. Without any such study it would be clear that leaves must render a very important service to the plant. Growth occurs only when a plant is furnished with leaves. Active growth appears to be dependent on the presence of the leaves. In autumn the leaves fall from most trees and growth ceases until the leaves reappear.

Shape of Leaves

The examination of an individual leaf from a tree or bush will reveal the fact that a leaf is—

1. Flat in shape with dimensions of length and breadth very much in excess of the thickness (in this connection realize how destructive frost would be to such a thin and delicate substance containing considerable water): the flat part is known as the *blade*.

2. Connected to the twig or branch by means of a thickened narrow *stem* or *stalk*

3. Furnished with *veins* which appear to be continuations and branches from the stalk, these can be seen by holding a leaf up to the light

4. Provided in some instances with two little leaves at the bottom of the stalk where it joins the stem.

Detailed observations on the shapes and sizes of leaves should now be made by the children. Leaves of all kinds should be brought by or obtained for the children.

Press some of the leaves. Let the children then trace round the outlines of the leaves in a drawing book with a pencil. These outlines should then be compared with the shapes of the leaves and any necessary corrections made The name of the tree or plant on which each leaf grew should then be put underneath the outline. It may be found that more skilful children can finish the outlines in Indian ink, making the outline to correspond in thickness with the texture of the leaf. The addition of the main veins and the stalk, and stipules if any, will complete the work. Here let a word of warning be given. Veins develop in each leaf according to a regular habit. It is necessary to see that the children look carefully and draw what they see.

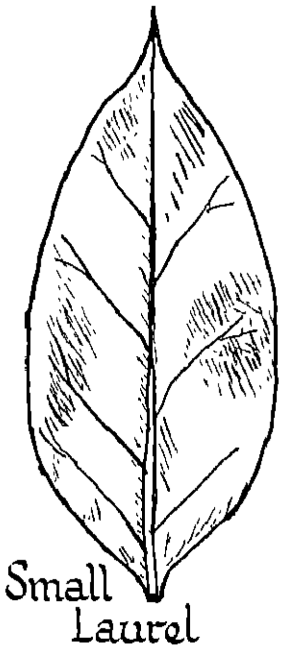


Fig. 39
A Simple Leaf

Simple and Compound Leaves. Where a leaf grows all in one piece it is called a *Simple Leaf*. Examples of simple leaves are to be found on the ivy, apple, pear, plum, laurel, and lettuce. Leaves which, like those of the horse chestnut for example, are formed of a number of leaflets are known as *Compound Leaves*. Some compound leaves are made up of a number of leaflets growing from a common middle stem, e.g the rose. Other examples of compound leaves are found in the clover, the pea, and the sycamore. Examination of the blackberry plant will reveal the fact that simple and compound leaves are present on the same plant

Skeleton Leaves. As leaves decay the tissue between the veins perishes first. It is, therefore, often possible, in the woods, to find leaves with

only the system of veins persisting. These are very useful for the purpose of demonstrating the methods of veining in various kinds of leaves.

Skeleton leaves can be obtained also in one or two other ways—

1. In autumn gather a number of leaves and place them in saucers. A good idea is to place one kind of leaf in each saucer. Add *rain* water and stand the saucers on a shelf in the open air. At intervals of a week brush the leaves with a paste brush or cheap tooth brush. Gradually the whole of the connecting tissue will decay. Then remove the skeleton leaves from the water Slowly and carefully dry them and press between blotting paper.

2. The process can be quickened by soaking in—

(*a*) a dilute solution of sodium hydrate or washing soda;

(*b*) a dilute solution of bleaching powder or hydrogen peroxide; or

(*c*) a soap solution made from patented washing powders containing bleachers.

The leaves should be thoroughly washed in several changes of water before they are dried and pressed, otherwise decay will continue.

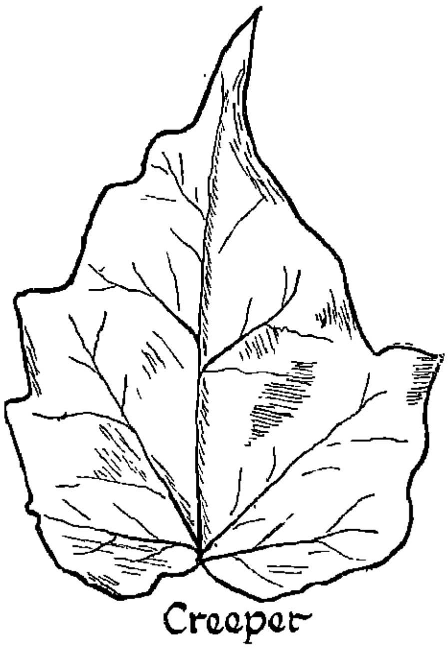


FIG 40.
Leaf of Virginia Creeper

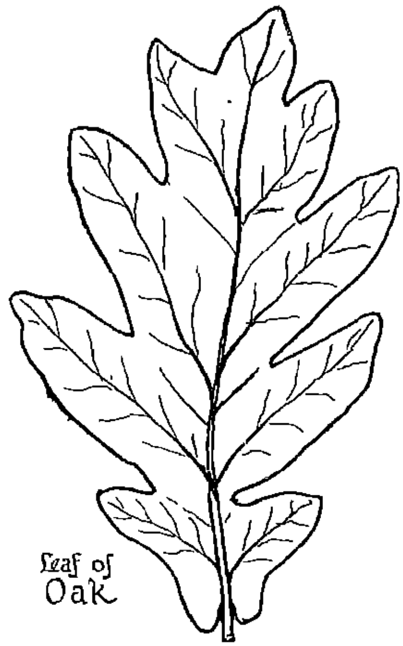


FIG. 41
Simple Oak Leaf

Veining

It is hardly necessary to burden children in the Junior School with the various technical names given to the types of veining. The distinctions between net veining and parallel veining only need be made. Notice that parallel veining is generally found in monocotyledons such as the grasses. There are some exceptions however.

Records of Work. Charts and records of leaves studied should be made, the following headings should be written in the Nature notebooks, and a number of leaves should be examined.

1. Name of leaf.

2. Kind of leaf—simple or compound.

3. Shape of tip of leaf—pointed, round, or other shape

4. Nature of edge of leaf—here indicate whether plain or toothed, smooth or hairy.

5. Nature of stipules—if none, are there any signs of such?

6. Kind of veining—net or parallel.
7. Colour and texture of under surface.

(Figs. 39–45 were drawn by a Junior boy, first in pencil, then in Indian ink.)

In making a selection of leaves the teacher must be careful to include each type. The following list of leaves may be found useful for reference—

Laurel, lime, oak, lettuce, clover, rose, sweet pea, strawberry, blackberry, horse chestnut, lupin, ivy, sycamore, grasses, wild arum, onion, dandelion, copper beech, sedge

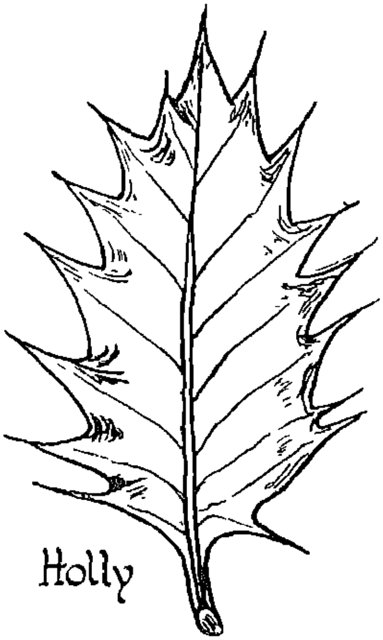


FIG. 42

Arrangement of Leaves on the Stem

Observations on trees, shrubs, and plants will show that there are several types of leaf arrangement. These should be studied with special reference to the habit of each plant. The necessity for allowing as many leaves as possible to be in the path of direct sunlight can be seen when the way in which plant food is manufactured within the leaf is studied.

Before talking about the various forms of leaf arrangement it is necessary for the teacher to understand the meaning of two terms used. A *node* is the point at which a leaf grows from the stem (Latin *nodus*, a knot). The length of stem between two nodes is termed the *internode*.

Opposite Leaves. When *two* leaves grow out from the same *node*, one on each side of the stem, then the leaves are said to be opposite. This arrangement is seen in the deadnettle, sunflower, ash, and horse chestnut. Examine any of these carefully and observe a curious thing. The next pair of leaves do *not* come out exactly above the pair below but at right angles to them. Thus more opportunity to receive sunlight is given to all the leaves

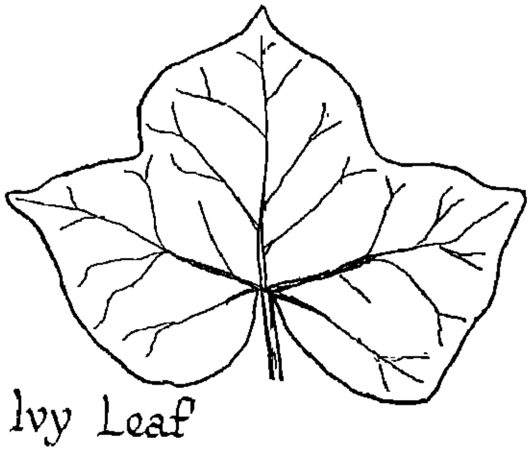


FIG. 43

Alternate Leaves. Where *one* leaf grows out at each node the arrangement is said to be alternate. In the broad bean the leaves grow out exactly on opposite sides Scientists have devised a simple way of describing the actual arrangement of alternate leaves by using fractions. The broad bean leaf is described as growing in the ½ arrangement. this means that in one passage round the stem *two* leaves are encountered If a crayon or pastel mark is traced from node to node on various stems the arrangement can be easily noticed.

Leaf arrangement fraction

$$= \frac{\text{Number of times the stem is encircled}}{\text{Number of leaves passed}}$$

The ½ arrangement is seen also in the following grasses, lime, elm, beech

The $\frac{1}{3}$ arrangement means that in one circling of the stem three leaves are passed. This is found in young hazel shoots, alder, and aspen. Notice that each leaf is arranged at an angle of 120° with the one below it.

In the $\frac{3}{8}$ arrangement the stem is encircled three times, and eight leaves are passed before one leaf is actually above another. The daisy is an example of this type.

FIG. 44

The oak is an example of the $\frac{2}{5}$ arrangement.

In some plants it will be found that the arrangement does not hold consistently. Pains should be taken to find out what external conditions cause this diversion. Crowding of plants, nearness of buildings, etc., may affect the general light supply.

Leaf Patterns

The desire that a plant has to see that its leaves are in as much direct light as possible can be observed very easily. By looking down upon a pot plant in the schoolroom it will be seen that the leaves are arranged with as little overlapping as possible In order that the light may be admitted the plant often develops leaves of quite a different shape The teacher must look out for examples of this Common ones that occur are—

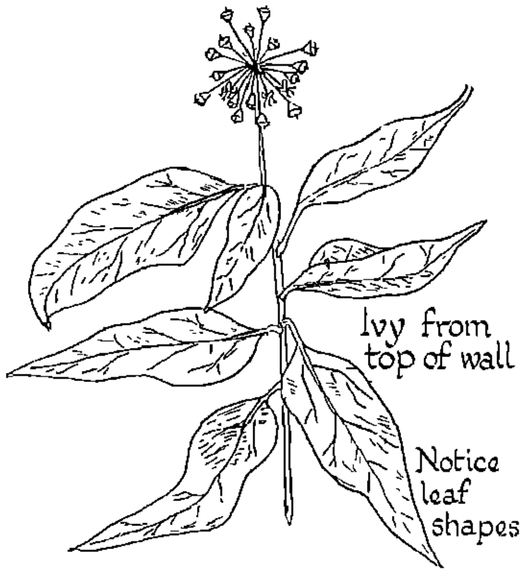


FIG 45

(*a*) The arrangement of daisy and dandelion leaves on lawns (show children dandelions growing in long grass and others on a lawn that is cut regularly—the lesson of plant preservation is worth noticing).

(*b*) The way in which ivy growing on walls forms patterns. Here again see if the ivy tops the wall. Should it do so, examine the leaves and compare them with those on the wall.

(*c*) The varying length of the leaf stalks of different trees.

In the horse chestnut the lower stalks are considerably longer. This enables the lower leaves to get more light and air. The keen nature observer will find examples every day. One most interesting method of work is to compare the different habits of the same plant when growing in different surroundings, as was indicated with the dandelion plant above.

Work of Leaves

It may be said that the leaves perform at least *three* functions—

1. They manufacture food (photosynthesis).
2. They give off waste gases (breathing).
3. They give off water vapour (transpiration).

By a series of experiments these three functions can be studied. The work is perhaps a little difficult for the Junior School. A complete outline of the work is given here, for the teacher alone can select that which is suitable for his or her own class.

1. *The Work of Food Manufacture.* The process is called photosynthesis, and has already been referred to in the section on germination. Read over Experiments 33, 34, and 35 again. For this process to take place the following four things are necessary—

(*a*) Light—see Experiment 33 · Germination.

(*b*) Chlorophyll—see Experiment 34 Germination.

(*c*) Carbon dioxide—see Experiment 35: Germination.

(*d*) Water—plant life cannot exist without water. This can be shown in many ways, e.g. the drooping of flowers and the death of a plant when denied water.

During the process of photosynthesis oxygen is given off by a plant. This can be shown as follows.

Obtain some weed from a pond, or get a small bunch of watercress. Tie a weight on to the plants so that they will sink. Place a glass funnel over the plants in a beaker of water. Fill the beaker almost to the brim with river or pond water. Place a test-tube full of water over the end of the funnel and stand the whole apparatus in the sunshine.

(Note that the teacher may find an easier way to fit up the apparatus by placing an empty test-tube on the funnel and then tilting the two right under water. Let the air escape from the tube and water will fill it. Then raise up the tube and funnel vertically. This method can be adopted only if the weed is sunk in a large bowl)

Bubbles of gas will rise from the cress and collect in the test-tube. If the gas is tested it will be found to ignite a glowing wooden splinter. This shows it to be *oxygen.*

If the experiment is performed with water which was first boiled and then cooled it will

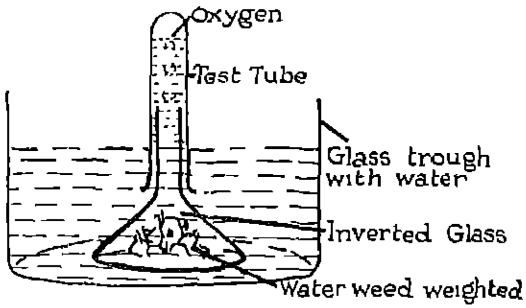


FIG. 46

Experiment to Show that Leaves give off Oxygen when Growing in Sunlight

be found that *no* gas is given off. This is because all the carbon dioxide which was originally dissolved in the water has been driven off in the process of boiling. No gas is given off in darkness either.

2. *The Work of Breathing.* In the last section it was shown that a leaf gave off *oxygen* as a part of the process of food manufacture. Another interesting function of the leaf gives the opposite effect. Men and animals breathe in air which contains oxygen, the life-giving gas The oxygen joins with carbon in the body and gives energy. Carbon dioxide, a gas made by the union of carbon and oxygen, is breathed out (A method of testing for this gas is given in Experiment 11 in the Germination section.) It is difficult to prove that plants in a similar way breathe out carbon dioxide because the oxygen given out during the process of photosynthesis hides the other process. It, nevertheless, does take place The similarity of this life process with that of

men and animals should be noticed. (See Experiment 11: Germination)

3. *Transpiration.* That a leaf gives off water in sunlight can easily be seen by the following experiment.

Bore a hole in a cork either end of which will fit into a medicine bottle. Into the hole fix a tree twig with leaves on it. Pour wax round the hole to stop up any crevices. Fill a medicine bottle with water, and put the waxed cork half way in. Using another medicine bottle, which is perfectly dry, push the twig into it and bring the bottle down on to the cork. Fix the bottles securely upright. Moisture forms in the upper bottle and could only have been given off by the twig.

Water vapour is being continually given off from the leaves and in some smaller measure from the stems of plants. It passes through small mouth-like openings called *stomata*. These stomata have automatically controlled mouths, so that the amount of water vapour that is released varies according to the conditions of heat and light in which the plant is placed.

When water evaporates, heat is needed to convert the water into vapour. Exactly in the same manner heat is required when any liquid is changed to a vapour. A spot of petrol, alcohol, or ether soon evaporates when placed on the palm of the hand. There is a sensation of coldness. This is because heat is taken from the hand in order to change the liquid to vapour. Now when water is given off, as water vapour, from a plant then heat is taken from the plant. This is valuable as it keeps the plant cool in hot weather and prevents the plant from destruction by the heat of the sun.

In addition, the transpiration of water vapour encourages the flow of sap from the roots upward through the plant. The pressure of this upward flow has a great deal to do with the rigidity of the stem in fleshy stems.

Leaves as Food

Many leaves are used as food by both man and animals. Grass, clover, sainfoin, and similar crops provide the staple food of horses, cattle, and sheep. Dried, these crops yield hay. Stacked in huge towers, called silos, the green fodder is used in winter.

The cabbage family is one of the most popular of those yielding human food. Among the varieties are—

Spring and Autumn Cabbages. The seed for spring cabbage is sown the first week in August, and that for autumn in March.

Brussels Sprouts. Here buds made of numerous interlapping leaves form in the nodes of the larger leaves. These *sprouts*, as they are called, are picked whilst firm and are boiled.

Savoy Cabbages have wrinkled leaves and form a solid heart very much in the same way as ordinary cabbages. They are best for food after they have experienced frosts.

The Kales are found in several varieties. In some the leaves are curled, in others, the edges are crinkled, whilst some kales have purple leaves.

Lettuces are grown for their leaves, which are used in salads. The cabbage lettuce is in shape something like a cabbage, but is smaller, and the leaves are a lighter colour. The cos lettuce grows taller, and is almost pyramidical in shape. (Illustrate buds, and should be grown on school plot.)

Mustard and Cress, two quickly growing crops, provide leaves for salads or for serving between slices of bread and butter. (Grow in boxes.)

Endive is another salad plant.

Spinach. The leaves of this plant are boiled before they are eaten; they are a particularly valuable food, as they contain iron.

It may be pointed out that leaves work only in sunlight, and it is the energy of the sun's rays that makes possible the manufacture of food by the leaves.

BUDS

These may be defined as shoots in the egg stage. Each bud, given favourable conditions, will grow into a shoot. The teacher will do well to spend some lessons on the study of buds. A great deal of the work can be done during the winter months, when the actual growing season is over, and consequently there is less to observe in the garden.

1. *Examination of a Brussels Sprout.* From October to, say, February it is quite easy to get

brussels sprouts. One sprout should be provided for each child, and, if possible, the teacher should get a complete plant.

Notice—

(*a*) Where the sprouts develop—in the axils of the leaves.

(*b*) How the leaves of the sprout are arranged—remove carefully—notice the way they are packed, how they are wrinkled, and how arranged.

(*c*) How the shape and colour of the leaves change toward the centre.

(*d*) That the section of the bud down the middle shows the complete stem with growing tip waiting to grow out.

(Here it should be explained that brussels sprouts would unfold in spring. Gardeners pick them before they do this as the tight little buds make a pleasant dish.)

Cut through a well hearted cabbage and a cos lettuce and show the same formations.

Now procure some twigs from well-known trees such as the *Beech*, *Horse Chestnut*, *Oak*, and *Lilac*. Place these in jars of water.

Some of these twigs will be used for Nature lessons and in the process of examination may be injured. Others, however, should be kept in water and drawings should be made to show the growth of the bud as it unfolds A warm schoolroom will cause many buds to open earlier indoors than in the open.

2. *Types of Bud*. Buds at the end of a twig are called *Terminal Buds*, those growing in the axils of leaves are known as *Axillary Buds*.

First Exercise. Examine twigs and notice the kind of terminal bud. Examine the axillary buds. If the leaves have fallen their positions can be seen from the *scars* left behind.

Second Exercise. Compare the positions of the axillary buds with the work done on leaf arrangement, and see whether the bud and leaf arrangement agree.

Third Exercise. Make drawings of leaf scars of different trees. It is not necessary in the Junior School to explain the reason for some of the markings, but after detailed examination of leaf scars the children should be able to recognize various twigs from these

The horse chestnut, elm, and maple have very distinct markings. The horse chestnut scars somewhat resemble a horse's hoof, and the markings almost resemble nails.

Fourth Exercise. Make drawings to show the comparative sizes of buds and the differences in their shapes.

The beech bud is long, pointed, and large, whilst the oak bud is fairly large but is ovate in shape.

Fifth Exercise. Examine the outer scales of the buds carefully. Are they made of a harder texture than an ordinary leaf? Is there any gum on the bud? A talk on the value of water-proofing substance can be given here with profit.

Sixth Exercise. Dissect various buds in turn. Take off the leaves one by one, notice their arrangement and the total number in each The oak, sycamore, and horse chestnut are three good buds to dissect. Whilst the sycamore has only seven pairs of scale leaves, the oak has twenty. A pine bud has more than a hundred.

Seventh Exercise Dissect the buds, noting how the leaves are wrapped together. Here are some types.

Rolled up like a piece of paper—plum.

Two halves rolled inward—apple (upper surfaces on inner), plane (inner surfaces on upper).

Plaited (fanlike)—sycamore.

Folded—elm.

Unfolded—chestnut.

The examination of the nature of the leaves within a bud and a determination as to their type should be left to the Senior School.

Bulbs

Great interest is always taken in the development of leaves and flowers from hyacinths and daffodils. The teacher should give one or two lessons on the nature of a bulb This can well follow those given on buds

FIG. 47
Section of Tulip Bulb

1. Cut an onion down the middle. Examine the section carefully Make a drawing of it. Observe—

(*a*) outside scale leaves,

(*b*) bases of last years leaves,

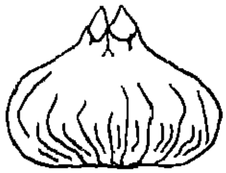
(*c*) young foliage leaves,

(*d*) the thick base which is really a short, swollen stem.

2 Cut a tulip bulb and a daffodil bulb down the middle. Make observations as in (1). Here notice the distinct parts of the flower Careful examination will also show in the axils of the leaves the buds which will form next year's bulbs.

Corms

If a crocus corm is cut down a difference will be seen between its construction and that of



Crocus Corm

FIG. 48

the bulb of a daffodil, hyacinth, or onion. The corm of the crocus is really a short, thick, underground stem which is globular in form. Carefully dissect a crocus corm.

1. Notice the outside scale leaves.

2. Cut the central solid piece in two and notice the veinings

3. Show that the swollen stem contains starch (iodine test).

4 Find if there are any other buds or traces of buds other than the main ones.

Now examine a section of the upper bud. Try to find the flower bud or buds—dissect one of these and see that all parts of a perfect flower are present.

A growing crocus should be observed, and its development watched. Watch for the following changes: (1) the formation of a new corm on top of the old and at the base of the flowering shoot; (2) the gradual withering of the old corm (the new corms develop from thickenings of the stem of axillary buds); (3) the swelling of the new corms from food supplied by the leaves (hence the folly of cutting off the leaves of corms or bulbs as soon as they have flowered), (4) the method adopted for burying the corms deeper—if a new corm forms on top of the old the new ones would eventually be too far out of the ground, but Nature provides a corrective: in the corm a root strikes down into the ground, anchors itself, and then contracts, pulling down the corm; contractile roots are found in other plants as, for example, in the wild bluebell and the dandelion.

THE FLOWERS

It has been said that the chief function of a plant is to produce seeds so that the life of the species may continue. In most plants the flower is the crowning glory that makes this process possible. The way in which the flower has developed through stages of evolution is not one which it is necessary to teach in the Junior School. It is, however, essential that young children should be able to recognize the chief parts of flowers and to understand the work and function of each of these. The study of flowers should occupy the spring and summer months of the school year. Germination experiments and examination of buds and leaves will occupy the autumn and winter sessions Fruits and the methods of seed dispersal will also be studied in the autumn.

Examination of a Simple Flower

In order that children shall become familiar with the various parts of a flower the first lessons should deal with the dissection and examination of simple flowers.

The Wallflower is an easy flower to procure in spring Proceed in the examination as follows—

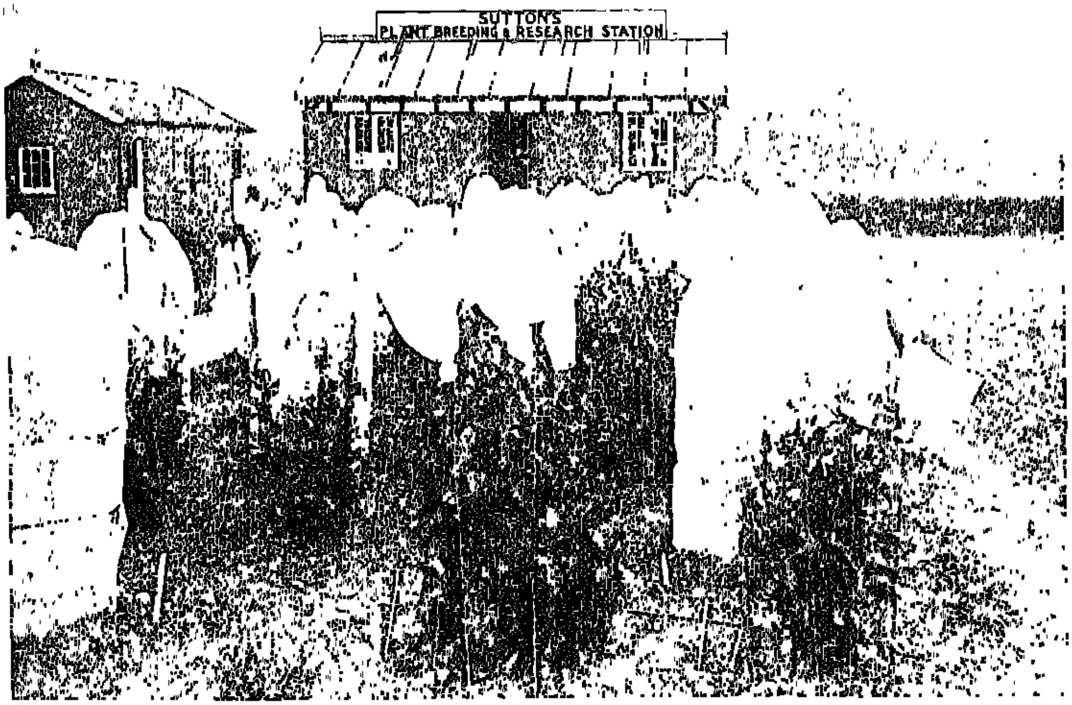
1. Notice the coloured part of the flower—describe this—the four coloured leaves that form this part are known as *Petals*.

2. Observe the arrangement in the form of a cross

3. Turn the flower upside down and notice that there are 4 purplish green leaves forming a cup. These leaves are called *Sepals.*

4. Strip off the sepals one by one Notice the swellings on two. Carefully find out what is enclosed within the swelling on the inner side A drop of sweet juice or *nectar* may be found Notice carefully these three defined parts. The whole pillar is known as the *pistil.* This is made up of *three* parts—the *stigma* at the top, the *ovary* at the bottom, and connecting these the *style.*

7. Open the ovary with an old pen nib, pen knife, or pin Notice the small round granules



By courtesy of *Messrs Sutton & Sons*

FIG. 49

A Plant Breeding and Research Station

The plants are covered with gauze to prevent cross fertilization of the flowers

Get the children to try to taste this. The point of a matchstick can be used to extract the juice. Just dip the point in.

5 Smell the petals, notice the sweet scent. Remove the petals gently The four petals constitute the *corolla* or *crown* of the flower Children may be asked to suggest why this name is given.

6. In the centre of the flower is an upright pillar. Its top is notched and sticky. Below this is a narrow stem and below a swollen part which will become seeds. (There may not always be developed seeds, however, in the ovary)

8 Round the central pistil are 6 erect structures, each made up of a narrow thread, *the filament,* with a yellow body on top. This is called an *anther.* The filament and anther together make up one *stamen*

9. Draw a rough diagram showing all the main parts of the wallflower blossom and add the names.

The Buttercup For the next lesson procure

buttercups and examine these, endeavouring to find the various parts discovered in the wallflower.

Notice in the buttercup—

1. There are 5 petals (describe shape and colour).

2. There are 5 sepals (each is distinct).

3. There are a large number of stamens. Each stamen is made up of a filament and anther. *Pollen* dust is found on each anther. The stamens grow from *below* the pistil (compare wallflower stamens).

4. The pistil is made up of a number of little green bodies—carpels. Find the three parts to each.

Make a drawing of a buttercup and show the various parts.

Other flowers that may be examined are—

The Wild Rose This has 5 sepals joined at the base. There are 5 petals and many stamens (*cf.* buttercup). The rose has numerous carpels each containing a seed, all grow inside the swollen part found below the sepals.

The Foxglove. Sepals—not distinct leaves—note number of points (5).

Petals—none distinct—corolla in one piece—describe mouth and note way in which lower lip protrudes.

Stamens—remove corolla: stamens grown on inside and there are *four;* observe position of anthers in a bunch and the length of the filaments.

Pistil—observe shape of stigma and its stickiness, the style is thread-like; the ovary has two divisions.

Flower Families

Flowers of like constructions are placed in families. The teacher should procure flowers of each kind to compare and contrast.

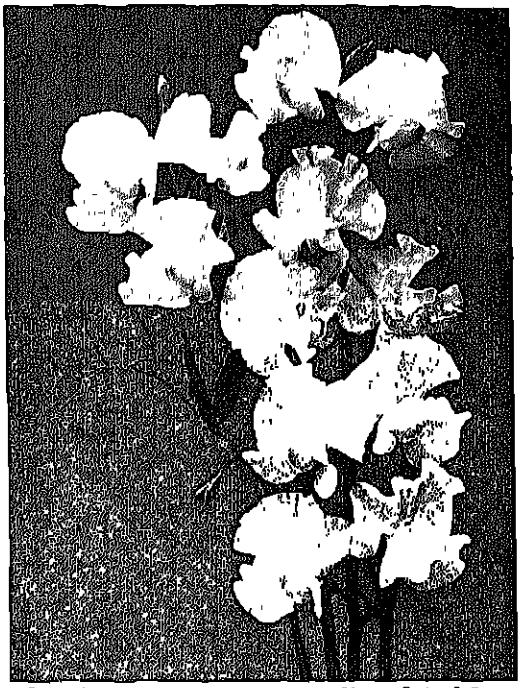
Wallflower Family Four petals arranged in the form of a cross—hence the name cruciferae (cross bearers). Over 1,500 members are known in this family. Here are some of the more common ones—candytuft, shepherd's purse, charlock (a yellow weed often seen in wheat fields), turnip, mustard.

Rose Family Blackberry, raspberry, strawberry (many carpels), apricot, plum, cherry (one carpel), hawthorn (2 carpels), apple, pear (5 carpels).

Buttercup Family. Marsh marigold, anemone, and monkshood.

Foxglove Family. Musk, antirrhinum (or snap dragon), calceolaria

Families which are rather more difficult to examine are the *Pea Family* and the *Nettle Family.*



By courtesy of *Messrs Sutton & Sons*

FIG. 50

Sweet Peas

(Children should examine flowers and notice how the weight of the bee causes the "keel" to open and expose stamens and pistil)

Uses of the Parts of a Flower

Having taught the children the way to recognize the various parts of a flower, the next stage is to teach the *use* of each of these parts. From observation of flowers it will be found that, after the petals and sepals have withered and the stamens have perished, a box or seed-case of some kind is left containing *seeds.* Thus it is clear

that the flower produces seed. How is the seed formed within the flower so that it will grow? Refer the children to the work of examining the ovary. Here the baby seeds were seen. Now if possible let the children examine the flowers on a vegetable marrow plant (or a cucumber). Notice that there are *two* kinds of flowers. One kind has *no stamens* whilst the other has *no carpels*. Show that the fruits form on the flowers which have no stamens. Watch insects at work and show how they go from one kind of flower to another. It can be proved by various experiments that pollen from a stamen must be transferred to the stigma for fertile seeds to be formed. These are too difficult for Junior children. It will thus be necessary for the teacher to give a simple description of the methods of fertilizing the seeds and of the work contributed by various parts of the flower. In order to do this return to the examination of a flower such as the wallflower or buttercup.

Work of the Calyx. This is made up of sepals. Show buds of various flowers. It is clear that in these the sepals form a protection for the delicate parts of the flower within (here note that *calyx* comes from a Greek word meaning *cup*). When the flower opens the remainder of the flower is sealed as it were upon or within the sepals

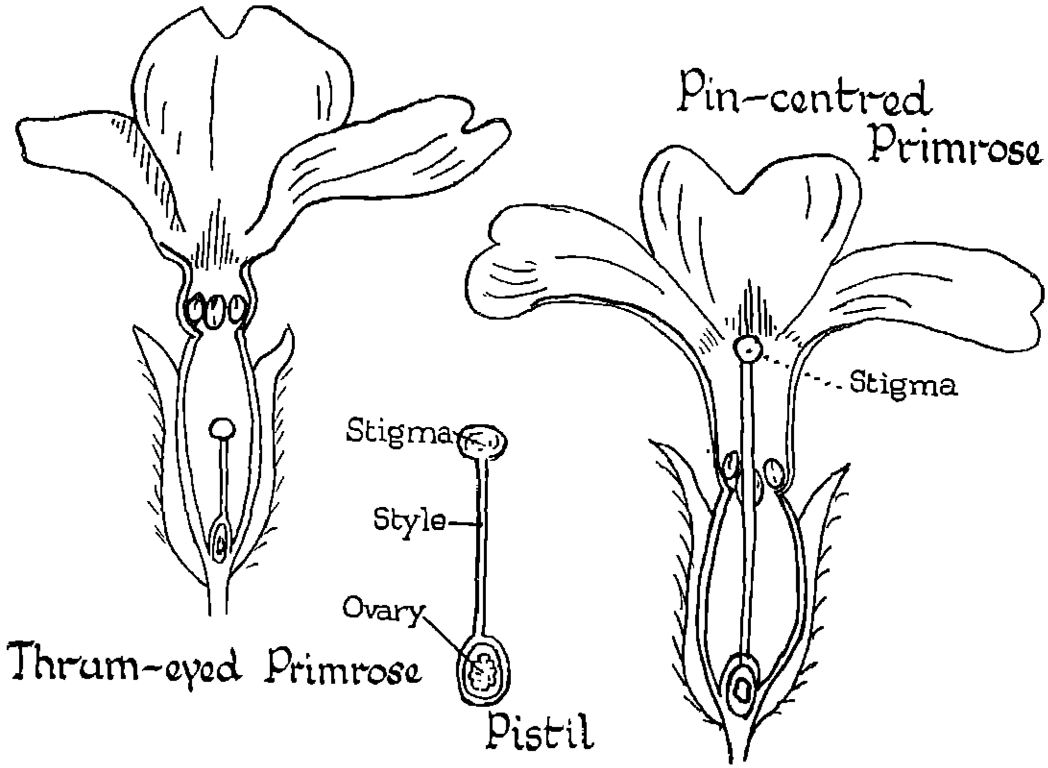


FIG. 51
Section Diagrams of the Two Types of Primrose Flower

Work of the Corolla. Again draw the attention of the children to the colour of the petals and to the *scent* of many flowers Do not for the moment try to deduce the reasons why colour and scent are present in the flower Return to this later.

The Stamens Remove the stamens of a fully developed flower and shake them over some white paper. The yellow dust which falls out

is known as *pollen*. Show flowers in various stages of development and explain how the anthers burst and reveal their golden pollen

The Pistil. Examine the pistil again and notice its three parts. Open the ovary and show the ovules inside. Now explain to the children that an ovule does not become a seed capable of growing until some pollen from another flower *of the same kind* has reached it Show that in many cases the *stigma* is sticky and that for this reason pollen will adhere to it quite easily. The pollen grain on the stigma swells up and develops a fine pollen-tube which grows through the style into the ovary. A little of the living substance of the pollen unites with the ovules and growth of the ovule can begin: life has been given to it.

This simple description of the need for pollen before the seed can become a source of life will give the children an idea of the importance of a flower's providing means by which the pollen can reach the stigma. Now the uses of colour and scent in the flower can be discussed. What different methods could be adopted to scatter pollen so that it reached stigmas of the same kind of flower? *The wind* may scatter some. The most common method adopted in Nature is that by which insects enter a flower, brush some of the pollen off on to their coats, and in visiting another flower leave some on the stigma as they pass.

The insects must have some attraction to visit a flower, otherwise they would not do so Hence flowers which desire the services of insects contain nectar. In order that its nectar shall be taken only by insects who render the service of transferring pollen, the flower adopts various means to stop intruders. Scent of flowers and bright-coloured corollas are other means of attraction.

A study of the insects visiting various flowers will reveal that they may be divided into four classes—(1) flies, (2) beetles, (3) wasps and bees, (4) moths and butterflies. Flies and beetles have tongues not much longer than $\frac{1}{10}$ in They are, therefore, able to obtain honey only from a shallow flower or from surface honey-sacs. Observations on the flowers of the *ivy*, stone crop, and the wild parsley will reveal interesting details of this type of insect fertilization.

Larger beetles and flies can get the honey from buttercups, some of the rose family, and other flowers

In such plants as gooseberries and currants the honey is still deeper down within the flower. The insects who desire this honey must possess tongues almost $\frac{1}{4}$ in. long.

The honey-bee, whose habits will be discussed later, visits numerous flowers where the honey can be reached only by a tongue at least $\frac{1}{4}$ in. long.

The largest bees, such as the bumble-bee, have longer tongues than the honey-bee. Observation will show that these bees visit the antirrhinums and the clovers. In this connection it is interesting to examine a clover head with its numerous florets Those which have been fertilized hang down and soon wither, leaving those which are unfertilized fresh and erect to attract the bees.

Examination of some flowers such as the Red Robin will show that the flower tube has been bitten through in some cases. This may be due to the ravages of bumble-bees, whose tongues are not long enough to reach the honey. They resort to this example of insect burglary, stealing the honey without repaying the plant by fertilizing its stigma. Moths and butterflies have longer tongues than bees, and it is very interesting to see which flowers are visited by these insects. The Hawk Moth can often be seen on honeysuckle.

Moths generally pollinate white or pale-coloured flowers. These flowers possess a sweet scent. The Tobacco plant with its white, delicately scented deep bell-like flower is a good example. By means of a flashlamp interesting insect visitors can be observed around the evening primrose and similar flowers on a fine summer night.

Flower Colours

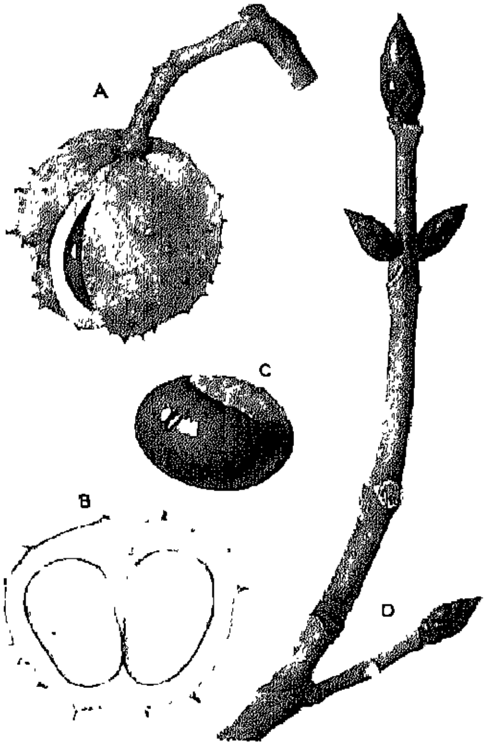
It is a most interesting exercise to find what flower-colour predominates during certain months of the year. The following method is suggested. Keep a flower diary. Note the name of the flower, its colour, and the kind of insects visiting it as each is observed on a chart. At the end of the year go over the chart and see whether any generalizations can be made. Is it true, for example, to say that yellow is the

BEECH

A. Flowering shoot × 4/5 B Male flower × 4 C Female catkin in longitudinal section × 4

ASH

Flowering shoot × 9/10 B Portion of inflorescence × 4 C Flower in longitudinal section, much enlarged D Winter twig × 2/3



HORSE-CHESTNUT

A Dehiscing fruit × 2/3 B Fruit in cross section × 2/3 C Seed × 2/3 D Winter twig × 2/3

PLATE II

By courtesy of British Museum (Natural History)

predominating colour in spring? Do bees favour violet and blue flowers? Are the yellow flowers visited by smaller and less highly formed insects than, say, the bees? What insects are attracted to white flowers? Can white flowers be divided into two classes—the simple white flower of daylight such as the cow parsley and the more elaborate sweet smelling flower of evening? Do butterflies prefer certain flowers? Watch a buddleia plant for instance. Which butterflies prefer to seek honey from the purple flowers found there? Here is a wide field for observation, and whilst no hard and fast rules can be laid down yet many preferences can be discovered.

Wind Pollination

Some plants and most of the English forest trees bear types of flowers which have neither scent, prominent colours, nor honey. In such cases the question may rightly be asked, How is the seed fertilized?

To answer this question the teacher might well give a lesson in the spring or early summer on *catkins.*

A Catkin is really made up of a loose cluster of flowers resembling a cat's tail. These catkins are found on certain trees in early spring. Observation of the catkins from various trees will show that—

1. There are two kinds of catkins, (*a*) male, (*b*) female.

2. The male catkin is longer than the female, and is made up of little flowers which have stamens but no pistils; pollen is made and is found on the bursting anthers.

3. Sometimes the female flowers are cone shaped; there is always a well developed pistil in each flower.

4. Pollen is carried by the wind from the male catkins and is deposited on the female stigmas; a considerable amount of pollen must be made as much will be wasted.

Observations to be Made on Individual Trees—

WILLOW. Flowers toward the end of March; male catkins broad and yellow, female catkins long and silvery, and *not* found on the same tree as male catkins; branches of willow are used on Palm Sunday.

POPLAR. Male and female flowers on different trees.

HAZEL. The favourite nut tree; long male catkins; female flowers like buds; stigma coloured red.

OAK. Note only flowers after considerable number of years (more than 40); female flowers above male, notice device for catching pollen.

BEECH and ALDER also have catkins.

The flowers of grasses are also pollinated by the wind. Grasses should be examined just before hay-making time to find what the tiny flowers look like. The pollen will brush off quite easily. The art of hay-making consists in cutting the grasses after the seeds have formed but before they are so ripe that they will fall from the ears in the process of harvesting.

The Daisy Family

Before leaving the question of flowers it is well for the children to study one of the flowers of the daisy family. Give each child a daisy. Present as a problem to be solved the task of finding the different parts of the flower.

The Calyx will be easily found and the white petals will be called the corolla. Difficulty will occur with what to call the yellow central part.

Tell the children to pull the head to pieces carefully and separate the yellow from the white. It will be seen after careful examination that—

1. The head of the daisy has a number of flowers of two kinds.

2. The white straps round the edge form the corollas of the *ray flowers*—each has a pistil.

3. The yellow flowers are like little tubes, and each is made up of five joined petals (notice the points); stamens and pistil are present.

The daisy can be pollinated by insects, or the younger florets in the centre, by exposing pollen first, may fertilize the older florets which show the stigmas only.

Advantages in this type of flower are seen in that—

1. The grouping of small florets together attracts insects better than would each floret growing singly.

2. Fertilization is doubly ensured.

3. Insects are attracted by a larger store of honey.

Courtesy of Messrs Sutton & Sons

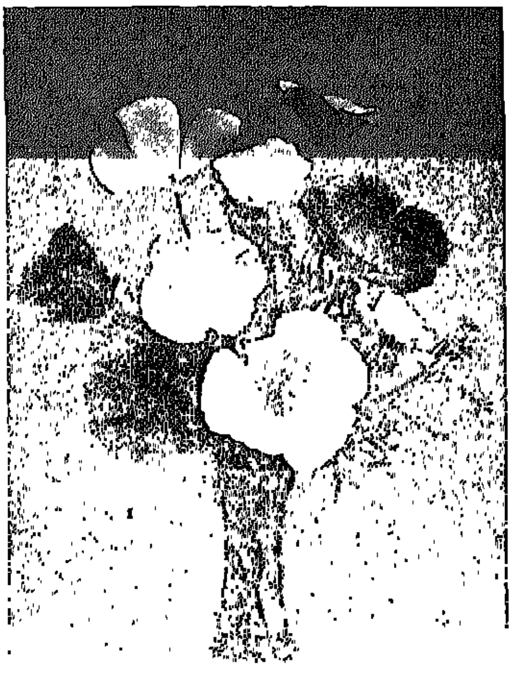
FIG. 52

"Southcote Beauty" Asters

Compare this flower with the common daisy.

Begonias, which are Suitable for Pot Plants in School

Lilies grown from Bulbs in the School Garden



Eschscholtzias, a popular Annual

By courtesy of Messrs. Sutton & Sons, Reading

Ornamental Grasses can be grown from Seed in the School Plot

FIG. 53. *Four Different Types of Cultivated Flowers*

FRUITS

After seeds are fertilized they begin to develop in size. Other parts of the flower grow at the same time. These parts together with the seeds they contain constitute the *fruit*.

Some instruction on the various types of fruit should be given in the Junior School, but there is no need to go into the more complicated questions as to the formation of fruit from one or more carpels. Early fruit contains at least one seed which has been fertilized, and therefore is a plant in embryo.

The chief types of fruit are—

1. Those with a dry fruit coat which splits when the seed is ripe, so that the seed is scattered.

2. Those with a dry fruit coat which opens only when the seed germinates.

3. Those with a fleshy coat.

Examples of each of these should be obtained and examined—

1. *Those in which the splitting of the fruit coat scatters the seeds*: the *wallflower* and *shepherd's purse*, where there is a double splitting each side of the central seed container, the pepper-box like case of the *poppy*, the three-fold case of the *violet*, and the transversely opening *pimpernel* case; watch also the formation of the seed cases of the marsh marigold, columbine, and larkspur; allow peas and beans to ripen fully, and watch how the pods open, compare the antirrhinum pods with those of the poppy.

2. *Those in which the seed coat remains intact till germination*: nuts are examples of this type; notice the fruit of the buttercup—each little fruit is called an *achene*; pick the head of a ripened dandelion flower and pull out each separate fruit—each is a type of achene.

The common berries—the strawberry, raspberry, and blackberry family are interesting. Here each achene is surrounded by soft, succulent pulp. The difference between the raspberry and blackberry with their little knob-like

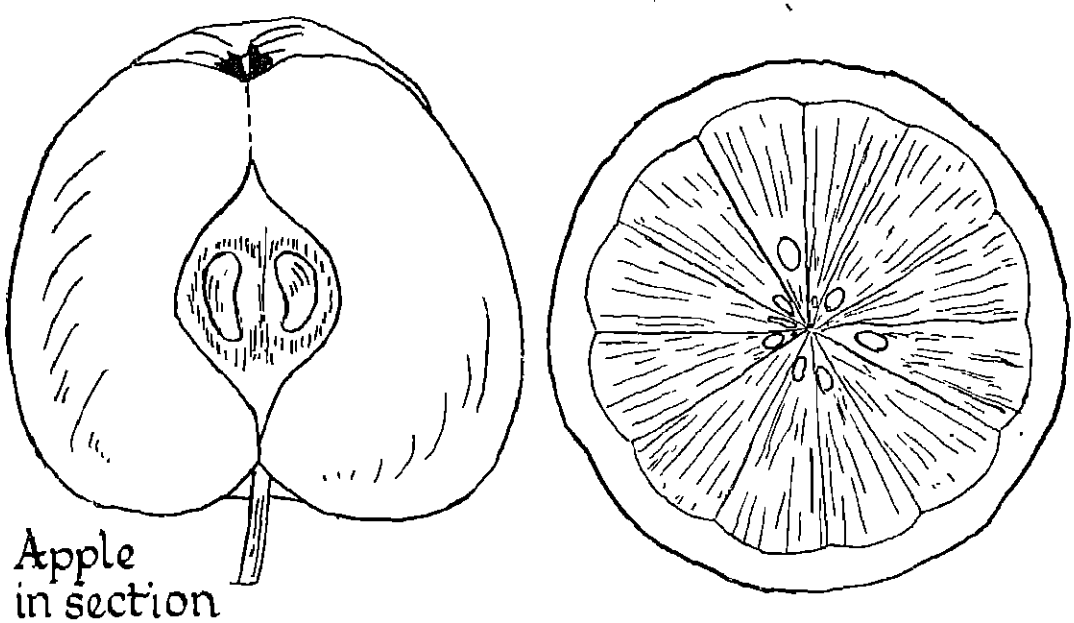


FIG. 54

Sectional Diagrams of Apple and Orange Fruits

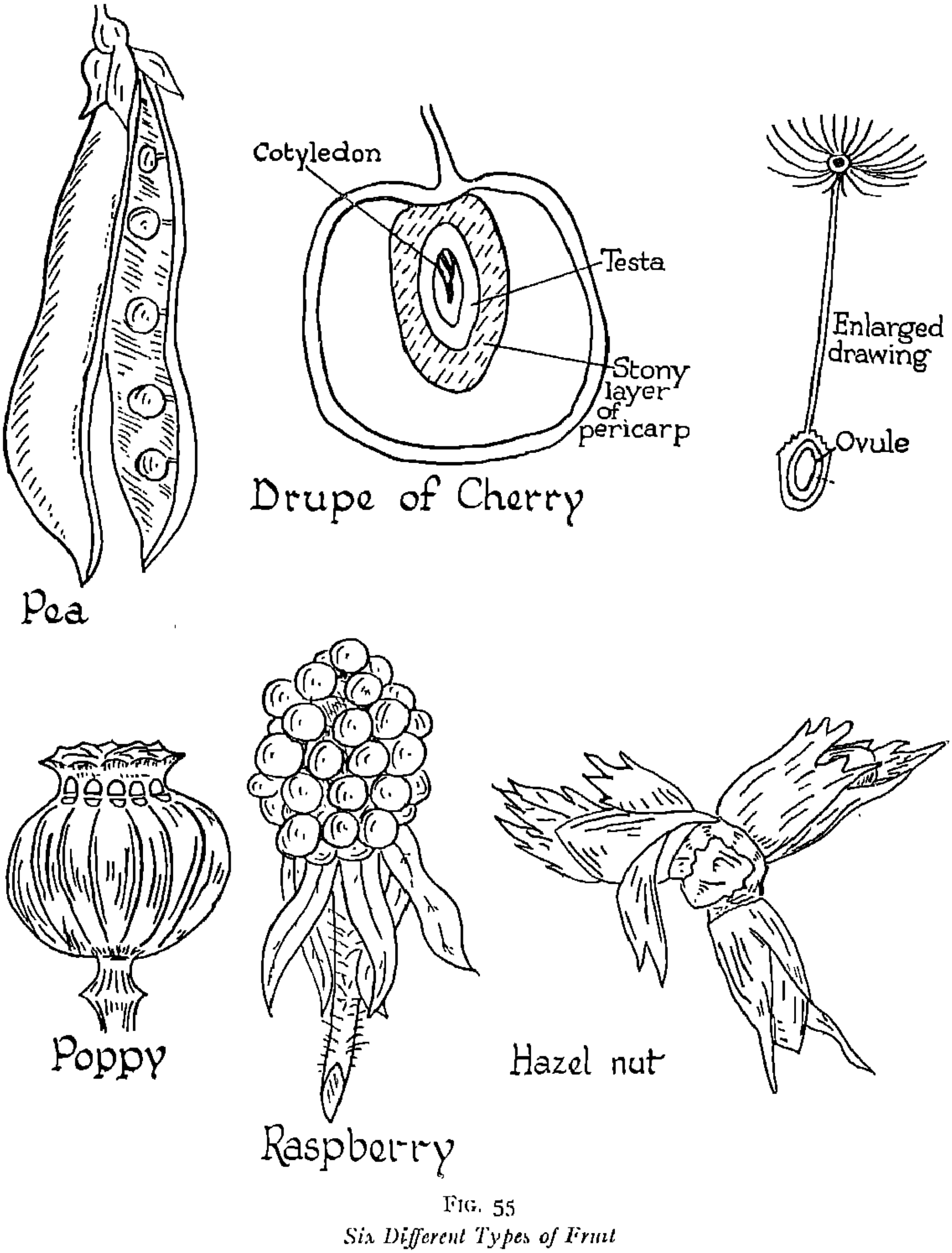
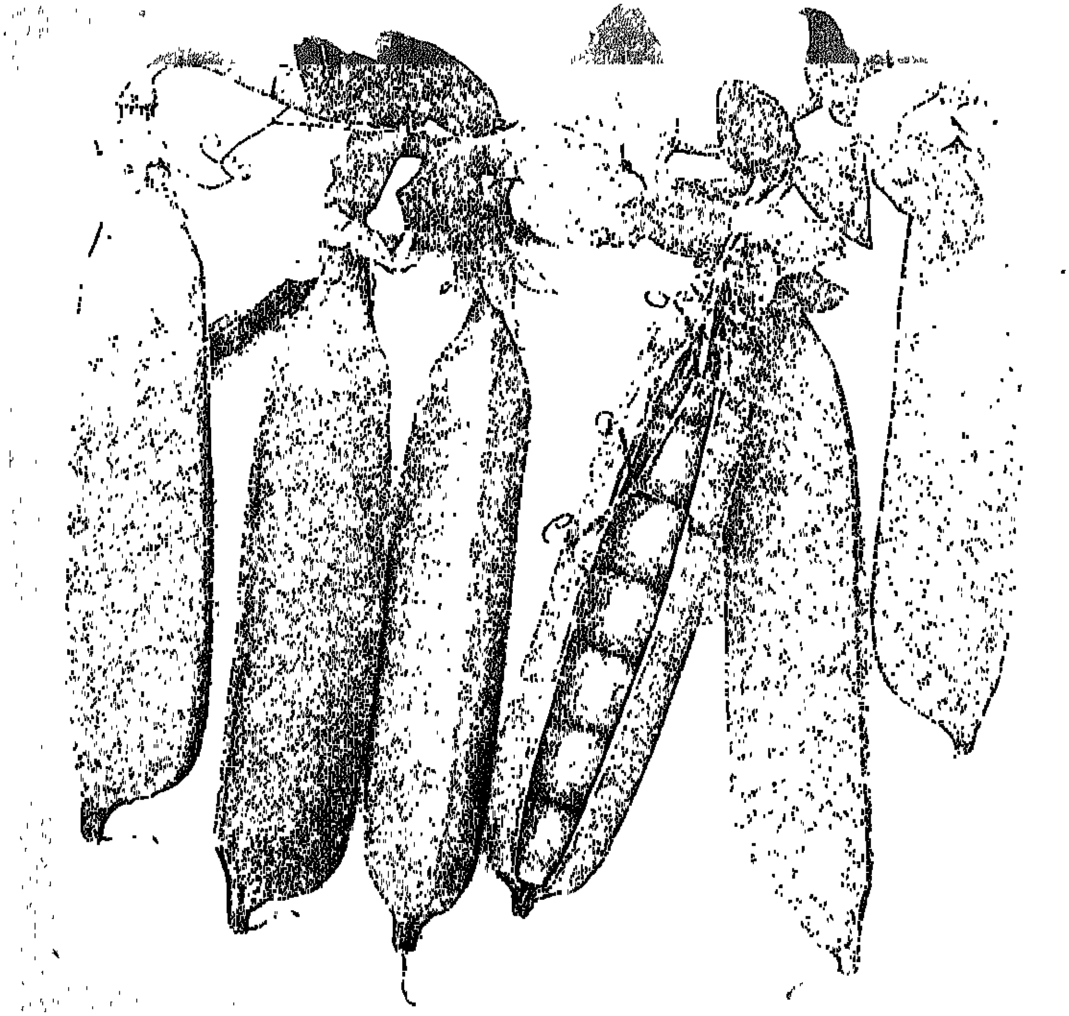


FIG. 55
Six Different Types of Fruit

structures and the strawberry with its fleshy centre should be noted. Each achene in the first two is surrounded by pulp. In the strawberry the achenes are all fixed in the one fleshy centre.

two parts and separate. The seed case does not separate generally, however, until germination takes place. Here may be classed the flying seeds of the sycamore



By courtesy of *Messrs Sutton & Sons*

FIG. 56

Garden Peas

This photograph illustrates very clearly the arrangement of the pods, the shape of the tendrils, and remains of the flowers

Here it is easy to see why blackberries and raspberries must be picked before the achenes are too hard.

Another interesting group of fruits originate in

3. *Fleshy Fruits.* Apart from the achenes found embedded in succulent pulp a number of fruits are surrounded by a fleshy substance.

Berries—Here one or more seeds are found

inside a soft substance: e.g. the currant, gooseberry, grape, orange, lemon, and tomato. The cucumber and marrow may also be placed in this class.

Drupes are fleshy fruits containing a *stone.* Inside the "stone" is the real seed. In a berry the real seed is enclosed in the soft flesh. Most drupes contain one "stone." Familiar examples are the plum, damson, and cherry. The walnut may be considered to be a drupe, the fleshy part consisting of the green covering which is removed before the *nut* is discovered. Those who have pickled walnuts will be familiar with the green coat and the brown stain which it leaves on the fingers.

The date is really a berry The flowers of the banana are rarely fertilized, otherwise the banana of commerce would contain seeds and might be included in the berry class

Pomes are fleshy fruits intermediary between the drupe and the berry. Without going into details it can be seen that the pips of apples and pears are the *seeds.* These are contained within a core and surrounding this is a fleshy part which is the edible portion. Other examples of pomes are the hawthorn, quince, and rowan fruits.

Dispersal of Seeds

Nature is very prodigal of her seeds. Most plants produce huge numbers of seeds. A simple experiment will show that such seeds

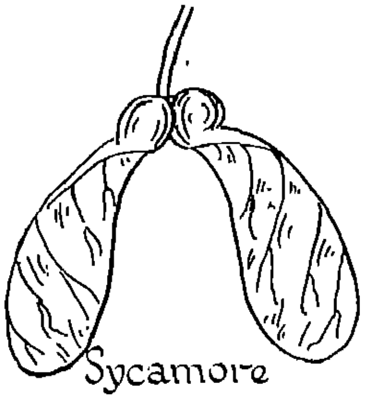


Fig. 57

would be of little use if allowed to grow in a limited space. Procure two small flower pots. Prepare with "crocks" and soil. In one sow two hundred mustard seeds. In the other sow two seeds. The results of overcrowding can easily be seen. Gardeners know the folly of allowing too many plants to grow in a row, and so thin out the seed beds.

In order to scatter the seeds they have produced plants and trees adopt various devices. In the autumn the children's attention should be drawn to the various methods.

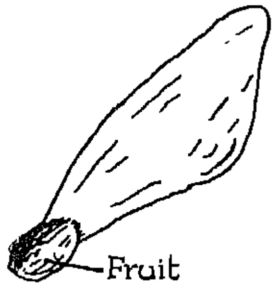


Fig. 58

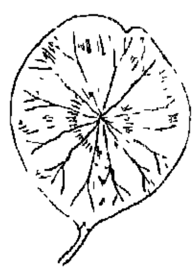


Fig. 59

Seeds carried by the Wind

1. Watch the progress of the tiny parachutes of the dandelion or coltsfoot fruit. The arrangement of the thin hairs above and the weighted fruit below is almost a perfect one to enable seeds to be carried some distance by the wind. Other plants whose fruit is carried in this way are the groundsel and thistle.

2. In the last class the fruit had a parachute attachment. The seeds of the willow, poplar, and willow herbs are coated with hair. This increases their bulk and decreases their density. The wind can easily carry such seeds.

3. The fruits of the pine are winged.

4 The ash, elm, and birch have winged fruits. The fruits of the sycamore and maple are made of more than one part each part becomes a winged fruit on splitting. The strong winds blow such fruit from the trees and carry them, with an interesting whirling movement, some distance from the parent trees.

5. The smaller seeds are often carried by the wind by reason of their shape and lightness. Notice how much farther it is possible to skim a flat stone than a rounded one. Look at the shape of the seeds of parsnip and wallflower. Wind scatters the seeds from poppy and snapdragon heads.

Seeds Dispersed by Water

Seeds of plants and trees growing near flowing water are often carried considerable distances. It would seem, however, as if Nature did not desire that they should travel too far, for most seeds when they have been long in water sink to the bottom.

Animals as Seed Carriers

Most children will have thrown various seeds and seed receptacles at one another, so that they stick to the clothing. Animals, especially

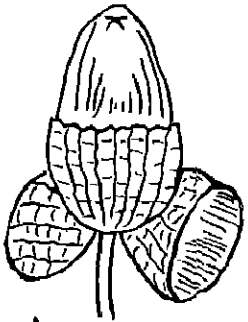


FIG. 60

those with woollen coats such as sheep, rub against plants which bear hooked fruits and carry off some of them. Examples of such fruits are found in goose grass, cleavers, and geums.

The burdock has "burrs" The *teasel* fruit heads are similarly formed.

Then it must be remembered that both birds and animals eat certain fruits. In both berries and drupes the seed-cases or the stones protect the germ of life, and these pass through the animals' bodies quite unharmed. Birds eat the succulent portion and discard the stone or seed, often wiping their beaks and so ridding themselves of seeds far from the place where they obtained the fruit.

Squirrels and other animals who store up a quantity of nuts frequently leave some uneaten. These, too, may germinate. Ants frequently carry gorse and other oily seeds away: after eating the oily part they discard the remainder, which germinates.

Fruits that Explode

Seeds are scattered in another way. Some seed-cases or fruits burst with explosive force, scattering the seeds to some distance. The force of explosion may be caused by the extreme dryness of the seed-box which causes tension, so that at the least touch it bursts. Examples of such are the gorse (the pop of the explosion can be heard) and the broom. The violet seed-box snicks the seeds many feet. The same thing can be observed with the pansy. Other examples can be noticed in the garden among the lupins and the geraniums.

FURTHER STUDY OF PLANT LIFE

The progress of growth has now been studied from the time when the seed germinates, the plant is formed, and produces seed which is scattered ready for a new life cycle The purpose of all the work given in this section has been to encourage pupils and teacher alike to study Nature at first hand, to observe, to notice, and to enjoy the wonderful things to be seen in growing plant life. It has not been possible within the compass of this chapter to exhaust the subject. The place of colour in Nature, the wonder of each of the seasons, the co-operation between man, animal, and plant, these are among the important subjects which might occupy the thought and interest of the Nature lover. Keeping their own records of Nature study excursions, with mounted specimens and drawings, will help Juniors to develop their liking for this fascinating subject.

BIRD LIFE

THE companionship of birds makes the world a much more interesting place in which to live. The merry notes of the songsters, the twittering of sparrows, and the far-away melody of the skylark bring music too often unheeded. In a lonely pine forest of Switzerland where bird life hardly exists the quiet becomes almost oppressive, but in such a place the joy of English bird life is perhaps realized more. The movements of birds, too, give interest and pleasure. Even in towns the hurried cheeky flight of the house sparrows is very commonly observed amidst the noise and bustle of the street. The starlings with their incessant noise and hustling manners are attractive. Visits of chaffinches, tits, and robins to gardens in winter give companionship and the promise of spring and nesting time. It should be the purpose of every teacher of Nature Study to foster a love of birds in the pupils, and to teach the best methods of studying the habits of birds.

The following quotations are taken from the Royal Society for the Protection of Birds pamphlet on Bird and Tree Study—

> The real history of a Bird is its life history The deepest interest attaches to everything that reveals the little mind which is behind the feathers —SEEBOHM
>
> The love of Birds, which takes delight in the study of them, is a gift which I regard as on the same level with a love of books and music and other things that are exquisite and rare. The pleasure of seeing and listening to them I believe to be purer and more lasting than any pleasure of excitement, and in the long run happier than personal success —VISCOUNT GREY OF FALLODON, K G

Observation

As in all other branches of Nature study the work must be almost entirely observational. It is not necessary to give information about birds so much as to provide children with the ability to observe what they can about birds. For such work it is first necessary to attempt to win the friendship of the birds. This can be done by providing various comforts for the birds.

Winter

Few people realize what a struggle birds have during severe frost to obtain a sufficient supply of food and water for their needs. Frozen ponds and streams are useless as drinking places. Ice-covered berries are not very palatable, and insect life and worms are unobtainable when the ground is frozen to the depth of some inches The gesture of friendship can be extended to birds in such a season by the provision of drinking water, crumbs, and other table scraps. It should also be remembered that saucers of water become frozen over, and the supply should be replenished at frequent intervals.

Bird Baths

One way to attract birds into a garden is to provide a bird bath. This is a stone or cement bowl, shallow, filled with water, and provided with a ledge. The bowl should be placed on a pillar at least 2 ft. high. Where the garden is very private and cats do not prowl, the bird bath may be on the ground or on a shorter pedestal. Birds, however, feel a greater sense of security and soon lose much of their shyness when the bird bath is some height from the ground. Considerable pleasure can be gained from watching the merry antics of the birds, and seeing how they carefully wash their feathers.

Bird Tables

These are somewhat similar in construction to bird baths, but they are stocked with food instead of water. The most suitable design, however, is one which is provided with a roof Thus when snow is on the ground the birds can comfortably eat food under shelter As the bird table does not have to hold any liquid, it can quite easily be constructed of wood. The base may well be fashioned like that of a jumping stand. Some 40 in. from the ground a platform about 15 in. square may be constructed of 1 in.

deal. The apex of the roof should be about 5 ft from the ground. It is wise to put not only bread crumbs on the board, but also pieces of lean and fat meat cut up into tiny scraps. Thus the meat eating birds will be attracted. In this connection it may be said that, if a large piece of fat is securely tied to an archway by a short length of rope, very soon a number of tits will be seen performing gymnastic feats on the meat and pecking at it to their hearts' content. Larger birds will sometimes frighten them away, but they soon return again. Small birds will also be attracted to a portion of a coco-nut suspended in the same way

Nesting Boxes

Where trees, bushes, and walls will permit of a certain amount of privacy for the birds it is often possible to attract some birds to nest in special boxes provided for the purpose These nesting boxes can be purchased for a few shillings —many interesting designs cost only four shillings each. Provision is made in some of these for a hinged lid. In one kind a little glass panel permits observations to be made. What a thrill of delight is felt when the first pair of birds begins to build in one of the nesting boxes provided by the pupils. For less than two shillings a coco-nut shell, with its fibrous outside covering, can be purchased. Small birds like the tits often build in such nuts which are sold cut out to make an ideal bird home.

Establishing Friendship

Confidence can be won in a school garden or at home where the birds are treated as friends. Many will become so tame during the winter that they will hop around the feet and even feed from the hand. This gives ideal opportunities for observing the colour of the plumage, the form and action of the feet, and the methods of feeding. It is very rarely possible, however, to win such complete confidence where cats are kept in the family. Birds and the members of the cat family have never been very great friends! Interesting sights can sometimes be seen in large cities near buildings where many birds nest. Crowds of birds may be seen round some one who comes regularly to feed them. It is as if the birds recognize a friend. Fearlessly they perch on hand, arm, and even hat. This is the spirit of confidence which children must endeavour to establish between themselves and the birds

How to Watch Birds

A telescope is a very valuable asset in a school where bird life is to be studied. The writer remembers many pleasant hours spent studying birds on the trees of a near-by orchard through a telescope. From a bedroom window it was possible to watch many interesting things which it would have been impossible to see with the naked eye. Many a bird who was thought to be a foe to the fruit grower was proved to be his very best friend. Binoculars and field glasses are also useful, but a higher power of magnification is possible with a good telescope. A teacher can often purchase one cheaply at an auction sale, or in a second-hand dealers' shop. Many of the first-class optical instrument makers deal,

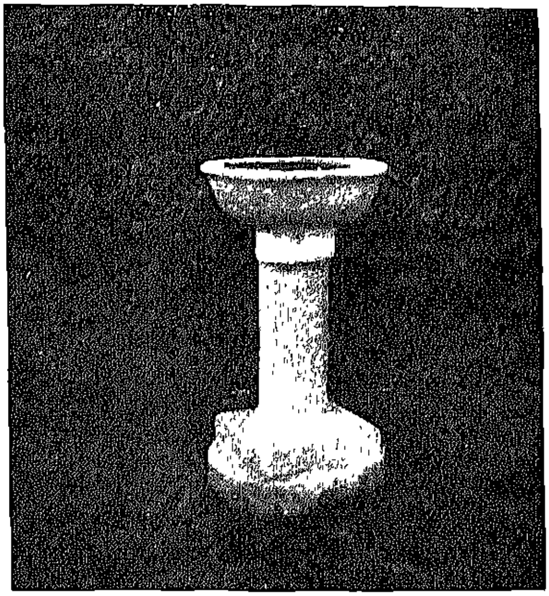


FIG. 61

School Bird Bath Made by Pupils

An old unglazed drainpipe was cemented into the base moulds (a sieve and a box)

too, in second-hand instruments which they have taken in exchange when purchasers have needed better or more powerful instruments.

Bird watching is possible, however, without any aids. *Quietly sitting* on a gate in a country lane, lying in a field on a summer's day, or even lounging on a park seat, one can observe their habits and customs. To do this successfully it is necessary to cultivate a tranquil habit of mind and body, to be alert, watchful, and still. Such gifts bring to the watcher more than a love of Nature, and a true study of bird life cultivated in such a manner will never lead to the mean habits of nest destruction, egg stealing, and bird *killing. There is neither art nor joy in these.* Rightly approached, observation of life gives respect for life, and a child rightly trained in the true spirit will never stoop to such mean and savage practices It is for the teacher to inculcate the right ideals.

BIRD STRUCTURE

This section will deal with the structure of a bird in a more or less general manner. A good deal of the information given is not intended for impartation to Junior children. The teacher, however, should have some idea of the structure of a bird in order to explain some of the functions of various parts of its body.

Skeletons of birds can be examined in many museums. The skeleton of a fowl can often be obtained from the kitchen. Some bones at any rate can be examined.

Modern research tends to show that birds developed from the reptiles. It is interesting to notice that reptiles are vertebrates, that is, they possess backbones. Their young are hatched from eggs, and they are often covered with scales. Birds are vertebrates, lay eggs, and have remains of scales upon the legs. The oldest known remains of a bird were discovered in stones of the Jurassic age in Bavaria. The name *Archaeopteryx* has been given to this bird, which evidently possessed many characteristics of the reptile. It had a long lizard-like tail, teeth in both jaws, and a simple kind of wing partly developed with three clawed fingers. The baby moorhen has a kind of hooked claw on the wing, which it uses to help itself scramble into the nest. This may be a relic of the ancient bird ancestor.

It would appear, too, from fossil remains that there existed at one time a number of winged reptiles. The Pterodactyls were one class of such reptiles. They varied in size from only 1 ft. in the spread of their wings to over 20 ft. The wings, like those of the bat, were attached to the body as well as to the fore limbs. Evidences of a horny beak were seen in some of the remains. The bones were hollow, the skulls pointed, and the eyes large. Remains have been discovered not only in parts of Europe but in North America.

There are many interesting problems which arise in connection with the definition of what birds are. If their ability to build nests is taken as distinctive it must be remembered that squirrels do this, and all birds do not build nests. The Platypus of Australia, a mammal, has webbed feet. The bat, which is not a bird, has wings and can fly but the Australian *Kiwi* has no real wings. The distinctive mark of a bird is its possession of feathers. A bird may then be said to be a warm blooded vertebrate covered with feathers.

The Skeleton

It may be best in studying the bony structure of a bird to see in what ways it differs in this particular from man.

The backbone of a bird is made up of a large number of *vertebrae* These are fused together in the region of the trunk and toward the tip of the tail. The neck vertebrae are capable of much more movement than any in the spinal column of man. The fused vertebrae at the end of the tail are known as the *pygostyle*, and on this the tail feathers are supported.

The ribs are attached in pairs to the backbone, and each rib has a hooked arrangement (uncinate processes) which overlaps the rib below. In front some of the ribs are attached to the breast bone (as in man), and there are also floating ribs (i.e. ribs attached to the vertebrae

of the spine but not to the breast bone). The breast bone is relatively large, and attached to it is a larger bone known as the keel. The muscles necessary for movement of the wings are supported by the breastbone and keel. In some birds that do not fly, the ostrich, for example, the keel is very small or is absent. The shoulder-blades are slender.

The "merry thought" is a V-shaped bone which consists of the united collar bones. These keep the wings apart.

The Skull. The shape of the brain case is large and round, and indicates that the brain of a bird is well developed. The jaw is prolonged into a horny beak which contains no teeth. The head is attached to the neck in a peculiar way. A round bone fits into the first vertebra of the neck. This rounded bone is known as a *condyle.* Reptiles have one, whilst mammals have *two.* This arrangement of the head on the neck makes it possible for a bird to turn its head so that it can move through half a circle on each side.

The Wing Bones. In man the skeleton of the arm is made up of—

(*a*) The humerus, the bone in the upper arm.

(*b*) The radius and ulna, two bones in the lower arm.

(*c*) The wrist (8 bones), hand (5 bones), and fingers (14 bones).

In the bird there is the humerus in the upper wing, the radius and ulna in the lower wing. The radius and ulna are in union near their ends, and the bones comparable to those of wrist and hand are joined together to make a strong support for the quills of the wing. In reality it may be said that the fingers in a bird consist of a well developed second finger and remains of two others.

The hind limbs are arranged farther from the base of the trunk than in man, so that when they are used for walking a balance is kept on them, a portion of the trunk behind counter-posing the head, neck, and remainder of the trunk. There is a large bone, *the femur*, in the upper leg, then a bone which is made of the union of a large *tibia* with a very small *fibula.* Evidences of a knee bone, *patella*, can also be seen.

The lower part of the leg, which is often described as the real leg, and which may not be covered with feathers, corresponds to the bones of the ankle in man. The toes of the hen are four in number, three being pointed forward and one backward. The arrangement of the toes varies in other birds, the cuckoo having two forward and two backward, whilst the ostrich has only two altogether, one much larger than the other.

Feathers

The peculiar structures which form the clothing of birds are worth some little study. There are several types of feathers—

(*a*) *The quill feathers* are the largest and are found in the tail and wings. The hollow horny *quill* is found at the base of each. This extends up into the body of the feather as a solid *shaft.* At each side of the shaft is the *web* or vane of the feather. This is made up of a large number of flat *barbs.* These barbs are interlocked together by hook-like attachments called *barbules.* These can be observed with a magnifying glass or microscope. Detailed observation will show that the barbules are not quite similar in structure on each side of the barb. The purpose of these attachments is to hold the web firmly together so that a surface impermeable to air can be formed. Examination of various quill feathers will show that the shaft does not always divide the web symmetrically. The wing feathers have narrower outer sides. Where barbules are absent, the feathers are fluffy. The wing feathers of the ostrich illustrate this, and this accounts for their lack of power. The shape of the surface of a quill feather may be noticed. It is not flat on both sides. The outer side is convex in outline. A study of a bird in flight will reveal the fact that the downward stroke of the wing takes in a maximum of surface, and a regular beat down on the air is noticed. The greatest resistance to the air is sought. On its upward stroke the wing moves at an angle and air resistance is much less.

The coverts overlap the quill feathers.

(*b*) *Contour feathers*, which give shape to the bird, are soft and much smaller than the quill feathers. Their purpose is to keep the bird warm. The temperature of a bird's blood is

considerably higher than that of man, and it is important that a substance which is a *bad* conductor of heat should cover the bird's body. These feathers are less highly developed, and have practically no interlocking barbules.

(c) *The Filoplumes.* Probably it has been noticed when a bird has been plucked that small fluffy outgrowths made up of a stalk bearing a few barbs are seen These are known as *filoplumes*.

Moulting. Periodically, once or twice a year, a bird begins to lose its feathers and grow new ones. A bird is able to fly properly only when its feathers are arranged symmetrically. Were all the wing feathers on one side to moult at the same time before those of the other, then the bird would be unable to fly For this reason owners of hens clip *one* wing of a fowl that is in the habit of flying off. The balance necessary for flight is destroyed. Nature is wise. Moulting takes place gradually and equally from each wing.

Baby birds are covered with loose feathers possessing no barbules. These feathers are known as *down*.

An oil sac at the upper side of the tail is used by a bird to "preen" its feathers. Before leaving the structure of a bird it will perhaps be well to describe some of the organs of a bird's body, and show how these function.

Breathing

In man, when air is taken into the lungs impurities of the body are given up and oxygen is absorbed into the blood. A bird, active and possessing a high temperature, needs a comparatively large supply of oxygen. Not only has it lungs but it has *air sacs*, which are connected with the lungs. These communicate with other parts of the body including some of the bones, which are *hollow*. This arrangement makes the density of the bird's body much less, and gives it that lightness so essential for a creature that flies.

The heart and blood system is somewhat similar to that of mammals. There are four chambers to the heart.

The Digestive System

The food is taken by means of the beak. There are no teeth. The food passes into a *crop*, an enlargement of the *gullet*, and is here softened. The stomach consists of two parts: (*a*) the *proventriculus* where gastric juice is poured on the food (this is somewhat similar to the action which occurs within the human stomach); (*b*) *the gizzard*, where the food is ground up into small particles. This bag is made of strong muscles and the bird frequently swallows small stones and similar hard substances for use in the gullet. This is how the bird is compensated for the fact that it possesses no teeth. Food then passes through a long intestine where as in mammals the digestible part is absorbed.

The Brain

A bird's brain does not possess the folded surface found in the brain of man. Brain convolutions mark very high intelligence. Certain senses are very highly developed, however, in the bird. Eyesight is particularly keen, and the organ of sight is so devised that both distant and near objects can be readily viewed. The eyes are provided with movable eyelids. The focusing arrangements can be varied by the pressure of a bony ring in front of the eye. This pressure alters the curvature of the eye lens. A kestrel hawk peering down into a field for likely prey must focus its eyes for distant vision. Diving earthward the bird must change the focus or it would be dashed to death against the ground.

Hearing is very acute although the ear has no external trumpet. The ear opening is hidden beneath the feathers.

Taste and smell are not very strong senses, though in birds that find their food in the mud of brooks and ponds or that probe into the earth these senses are probably present to some degree.

Flight of Birds

All birds do not fly in the same way There is great difference, for example, between the apparently lazy flying of the rooks (though these travel at over 20 miles an hour), and the rapid darting flight of the swallows. The soaring of the skylark is dissimilar to the flight of the blackbird. It is a splendid exercise in the use

of words to get children to describe the differences in the flight of birds.

In general it can be said that—

1. The downward beats of the wings keep the bird up in the air.

2. The backward movements push it forward.

The new sport of gliding, in which machines heavier than air but without engines sail in the wind when launched from a height, has shown man the way in which wind currents can be used Birds know how to use these for soaring.

In *hovering* the wings move very quickly.

The shape of the bird with its breast built to cleave the air, and its stream-lined body, together with the hollow bones and air sacs all aid flight.

Interesting lessons can be given to children on the modification of feet and beaks for different purposes

Feet of Birds

The Birds of Prey Those birds which obtain their food by the capture of living creatures on land have feet especially adapted for the killing and carrying of their prey The claws or toes, of which there are four, are furnished with strong cruel-looking talons Amongst birds of this class which may be found in the British Isles are—

1. *The Vultures.* It is doubtful whether these may be considered British birds. A few have been shot it is true, but the vulture is not common.

2. *The Owl Family* The large heads and the ruff of feathers round the eyes make it easy to distinguish members of this family. Six kinds of British owls are known. Among the commonest are—

(*a*) *The barn owl*, by reason of its screech it

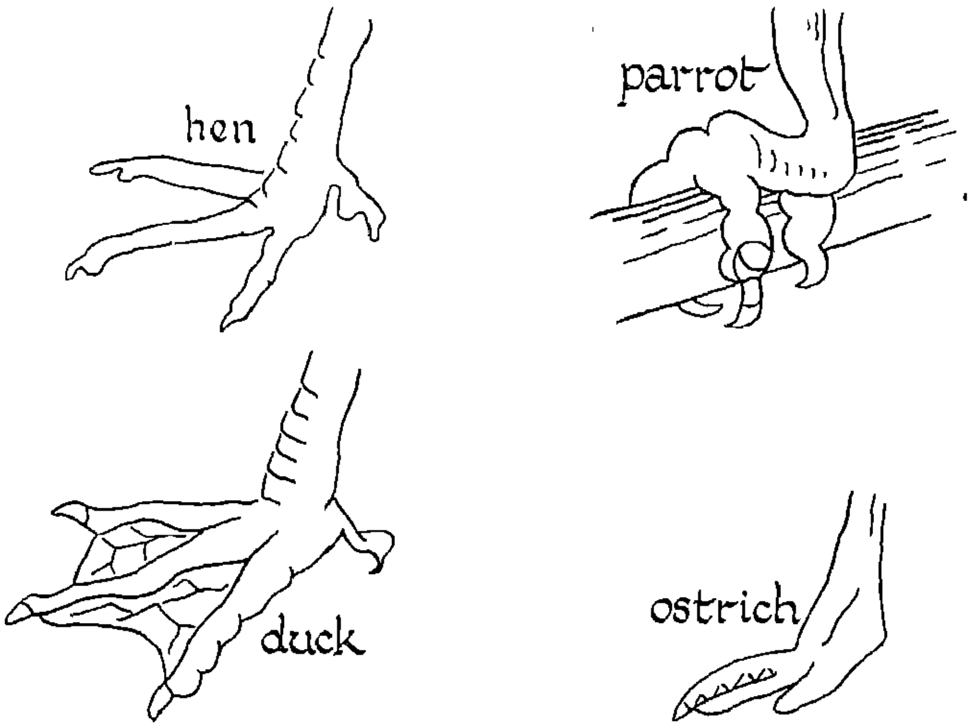


FIG. 62

Feet of Birds, Showing Adaptation to Present Habits

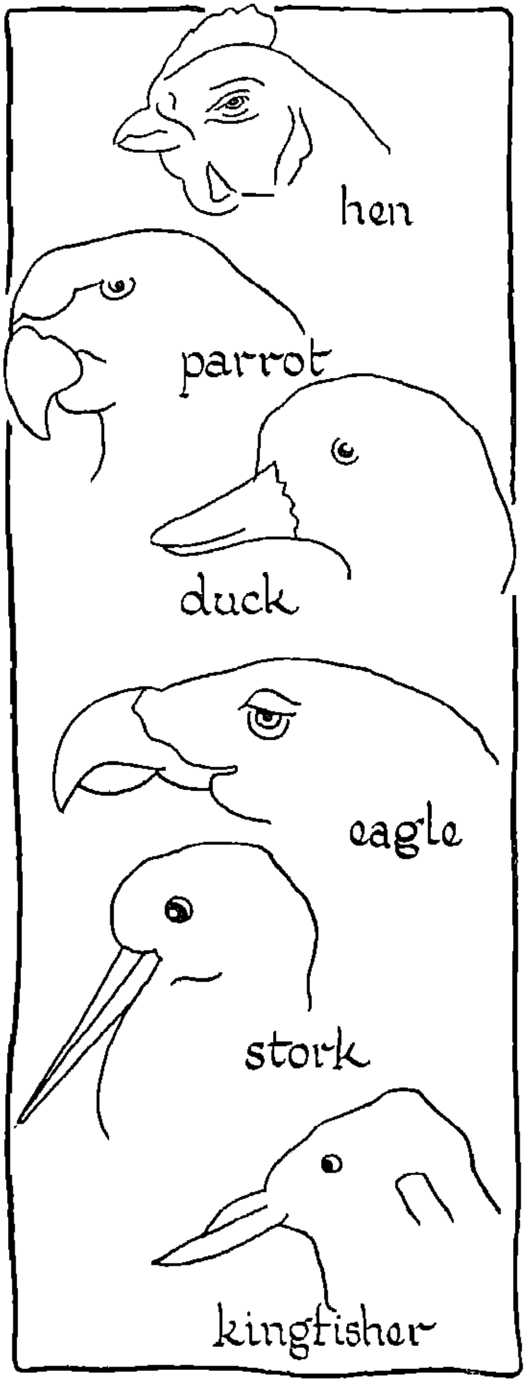


FIG. 63
Heads of Birds, Showing Adaptation to Habits

is sometimes known as the *screech owl*: it often lives in a church tower or in a hole in a tree; in colour it is tawny yellow above and white round the face and under surfaces.

(*b*) *The long-eared owl*: as its name indicates, it has prominent ears; it feeds on small birds and insects, and lives in thick woods.

(*c*) *The short-eared owl*, which has a buff face and dark feathers on the head, and is yellowish brown generally; it visits the British Isles in winter.

(*d*) *The tawny owl*, which is larger and rounder in size and outline than the other owls; it is found in woods in England, Wales, and Scotland, its call is the "hoot."

3 *The Falcons*. The name falcon is derived from a Latin word *falx*, a sickle. The shape of the talons is indicated by this name. In the true falcon class it is usual to include not only the falcons, but also hawks, kites, and eagles. Of the true falcons, the peregrine falcon is found on cliffs in the South of England. Hawking, an ancient sport, consisted in hunting with trained birds. Falcons and hawks were used The peregrine falcon and the Iceland and Greenland falcons were used for the sport as well as the shorter-winged hawks

Hawks. Several hawks are to be found in the British Isles. The common kestral hawk is often seen hovering in the air with its wings quivering. Suddenly the hover will cease and flight earthward will begin. The bird sometimes hovers again nearer the earth. The kites rarely visit these islands now.

4. *The eagles* are the largest members of the birds of prey group. The golden eagle is sometimes seen in Scotland, but rarely in England. A white-tailed sea eagle is found in the Hebrides. The great eagles of the world are found in the mountain ranges of the larger continents.

(*The Vultures* are another group of birds of prey found abroad. In all but one kind the head and neck are bare of feathers This distinguishes them from the hawks and eagles)

Climbing birds have four toes, two of which are behind and two in front. The toes are rather long The cuckoo and woodpecker can be placed in this class.

Swimming birds have toes specially adapted

for swimming by means of webbing stretched between them. There are generally four toes, three in front and one small remnant of a toe behind, known as a "dew claw." Ducks, swans, and geese of the common domestic water birds are examples of birds with such feet. Other birds in this class are sand pipers, plovers, and many wading birds. Observation will show that the webbing is not so complete in the waders

Running Birds. The ostrich has two toes and one of these is but a tiny one. The same structure can be seen on the feet of other running birds. Quicker locomotion is possible with but one toe.

Scratchers. Observation of the foot of the common fowl will show that it is well adapted for scratching amongst litter in order to reveal food to the bird. Notice the three toes in front, one behind, and the little spur above. The toes of all scratchers are very flexible and move easily.

The Heads of Birds

These also are adapted to the needs of the bird. Especially is this the case with the way in which the beak is formed. The beak is usually the *hand* of the bird as well as the mouth, the limbs which correspond to the arm in man being used for flight.

Some types of beaks which call for attention are—

(*a*) *The hooked beak* of the bird of prey. The eagles, hawks, and owls all have hooked beaks. In some there is a definite indentation of the beak as well (compare teeth). Some birds, such as the cuckoo and some of the game birds, have beaks which tend to be hooked. The hooked beak of the parrot is used in climbing trees.

(*b*) *The spoon-bill* of the duck family is specially adapted for use in mud. The water and mud can be filtered through its sides, and insects and living organisms can be retained in the mouth.

(*c*) *The gaping mouth* of the birds which gather insects whilst on the wing is interesting. A fringe of hairy bristles is found at its edge to prevent the escape of the insects. Swallows, swifts, and night jars have this type of mouth.

(*d*) *The seed-cracking bill* is straight and sharp pointed. Examine the finches and tits for such beaks

(*e*) *The wood pecking and boring beak* is wedge-shaped, very strong, and fairly long. The woodpeckers possess such beaks, as does also the kingfisher and the nuthatch.

Other interesting beaks can be found in the *pelican*, the bird whose beak is a storehouse for food, the *razor-bill*, with its laterally flattened beak, the *tree-creeper*, with its long, curved, slender beak, and the *crossbill*, whose mandibles actually cross each other: this permits the bird to extract seeds from fir cones.

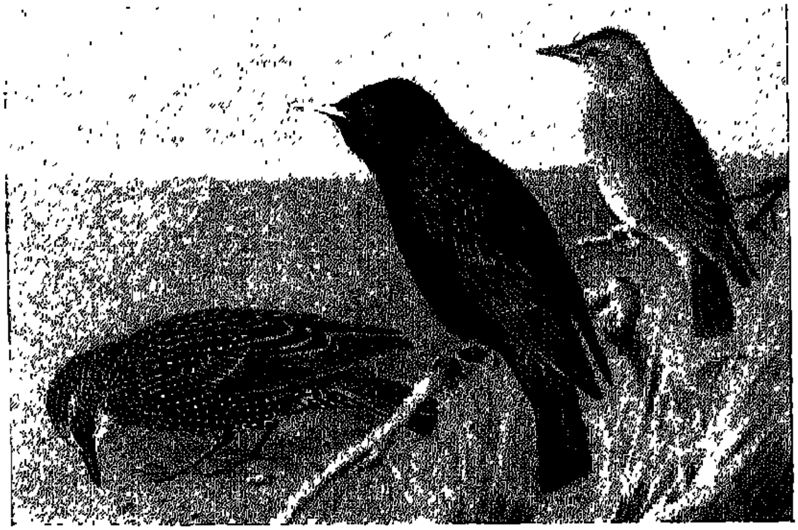
The adaptation of beak and feet for the work and life of the bird cannot well be the subject of very great observation The teacher should give a lesson on the subject illustrated, when possible, by pictures and sketches. The children can then be encouraged to watch the feet and beaks of the more common birds.

Do Birds Walk or Hop?

This interesting question can best be answered from actual bird observation. In general the perching birds *hop*; there are, however, exceptions to the rule. Watch the starlings, the larks, the crows, and the wagtails. They all walk. Have you ever seen a thrush go off almost at a run?

MIGRATION OF BIRDS

The fact that the same birds cannot be observed during all seasons can be made quite clear to young children by reference to the cuckoo and the swallow. Nature calendars will show when the notes of the cuckoo are first heard The arrival of the cuckoo is quite a good time of the year to give a lesson on the migration of birds. Other suitable times are when the swallows arrive and when they gather together ready to depart, when the lapwings are noticed in the fields, and when the nightingale is first heard to sing.



1/6 Natural Size

STARLING

3/4 Natural Size

CHAFFINCH

MARTIN

PLATE III
BRITISH BIRDS

By courtesy of British Museum (Natural History)

The next question will then be as to why the birds come and go from season to season. Some information is given here which will provide an answer to this question. All of it is not meant for the children. The teacher will discriminate as to the amount which the class under instruction can assimilate. The teacher, however, will be better able to decide on the syllabus if in possession of a fuller outline of the subject. The careful observation of birds and the chronicling of the dates of arrival and preparation for departures on the Nature diary will be extremely helpful.

What is Migration?

This may be defined as the periodic movements of large numbers of birds, animals, or insects from one place of habitation to another. The teacher must not forget that insects and animals of certain species migrate in a somewhat similar way to birds. Some fishes also make such journeys.

A few words may be first given on the migration of other creatures than birds.

Migration of Fishes

All those who take an interest in the movement of fishing fleets know that the trawlers that seek the herring and the mackerel move from place to place round the coast. The lassies that prepare the fish for market may be at one time at Oban, at another in Yarmouth, and yet again at Whitby. The large shoals of fish in pursuit of small creatures of the sea, or seeking the most favourable conditions of temperature and water conditions, move about. The boats follow the shoals. The movement of these fish cannot be said to be true migration.

On the other hand, the salmon illustrates almost a true migration The young salmon, when nearly two years old, are known as "smolts." These leave the river where they have lived since birth and go out into the salt ocean They do not return until they are fully grown and ready to spawn Salmon are caught for food as they enter the river at this season, for they are then in fine condition. Similarly the eel has a migratory passage. The females from ponds, rivers, and lakes travel to the sea, even crossing fields at the urge of Nature. Males travel similarly but the majority of these are never found far from the mouths of rivers. The spawning is done far out at sea. The tiny eels, quite unlike their parents, find their way to rivers and inland waters there to develop and grow to the adult stage.

Migration of Animals

In their wild state animals move from place to place in search of food. Such spasmodic movements are not truly migratory. One animal the lemming, a rodent of Scandinavia, is peculiar in its movements. From time to time great hordes of these creatures begin to march toward the sea. They cross hills and valleys, devastating the country as they go. When they arrive at the sea they plunge in and swim out until they are drowned—normally they dislike water. This is not a true migratory journey as the return journey is never made! It seems as if it is an instinct which enters into a large colony when it is becoming overcrowded Thus a smaller number are left behind, and food and room is there in plenty.

Migration of Insects

Movements somewhat similar to those of the lemming have been observed in the white butterfly. Swarms have been seen flying in clouds above the snow line in the Himalayas, where they perish. Butterflies in eastern America often make a true migratory journey to California during the cold weather. Here they feed and thrive. The periodic movement of locusts in huge swarms, devastating the country over which they pass, is a type of migration

Birds

The seasonal movements of birds illustrate the true migratory journey. The birds which migrate live for two portions of the year in different parts of the world, making a journey in each direction annually. In their summer home they nest and breed, whilst in their winter home they rest and eat. Notice, however, especially that the climate of the winter home

may be very similar to that of the nesting home Generally the birds nest in the most northern point of their migratory track and rest in the south.

Causes of migration are not always clear, but it may be said generally that birds move—

1 In order to get food supplies which would fail otherwise because of wintry weather (this especially applies to insect-eating birds).

2. To enable the young birds to secure food, rest, and climatic conditions that encourage growth so that they will be ready to lay eggs and rear families in the next nesting season.

Migratory Movement

Birds generally travel to the same latitude south of the Equator as that in which they nest in northern latitudes, i.e. they seek out climatic conditions to which they are more or less accustomed. This is not always true, however, for some birds, say in Central Europe, fly westward to the warmer sea board. Birds, too, which in summer live farther north than the British Isles, in winter may find conditions suitable for them in these islands.

Migratory Routes

Observation of various species of migratory birds has proved that well defined routes are taken. Swallows fly almost directly south from Britain. Some flocks of birds follow coast lines, others river valleys, whilst others seem to have a track which passes over islands. Birds travel at different heights, and some by day and others by night. The long journey takes toll of the weaklings, and birds are often found, especially after rough and stormy weather, exhausted or dead. The track of these who fall by the wayside helps the student of bird life to follow the path of the migrants. Pilots of airplanes have often been able to supply interesting information about birds and their migratory journeys.

The birds of the British Isles, or indeed of any land, may be divided into several classes: (*a*) residents, i.e. birds who do not leave the country at all; (*b*) summer visitors; (*c*) winter visitors; (*d*) birds of passage which pass over and perhaps stay a short time in the country.

The following lists may be helpful—though they are meant not to be exhaustive but to include the more common birds—

(*a*) Residents—sparrow, wren, tit, woodpecker, game-birds, magpie, barn owl, long-eared owl.

(*b*) Summer visitors—yellow wagtail, nightingale, swallow, cuckoo, turtle dove, sand martin, swift.

(*c*) Winter visitors—Sandpiper, short eared owl, fieldfare, redwing, white-fronted goose.

(*d*) Birds of passage—goldfinch, stints, and sanderlings—however often stay for some time.

BIRDS' EGGS AND NESTS

The Junior Nature Course should include some lessons on eggs. Their structure, shape, and colouring provide useful data, and the beginning of new lives from eggs is worth study. Of course, serious biological studies are not intended, but glimpses of the truths to come are worth while.

The first work can be done by considering a hen's egg. Children are familiar with this as food This should be remembered when the use of the stored food within the egg is discussed.

The Outer Appearance. Describe appearance of shell, shape, colour, texture, observe that neither texture nor colour is the same in all eggs. Various breeds of fowls lay differently coloured eggs, though they may be classed generally as brown or white. *Leghorns* lay white eggs and *Rhode Island Reds* lay brown eggs, for example Some people think that there is more nourishment in a brown-shelled egg than in one with a white shell. There is *no* truth in this. Food value is the same in both cases.

Examine the shape. This is described as *ovoid*. Make up a sphere, a cylinder, and an ovoid in clay. Roll them on a flat table. Notice how the egg shape is least readily rolled from the table. Make other models where there is a greater difference between the rounded and pointed ends of the egg than that found in the hen's egg. Point out the value of such shapes where the eggs are laid directly on the ground,

especially on a rocky ledge. Notice that a pointed or crinkled surface would also prevent movement, but would be unsuitable for the hatching process. Show how the ovoid shape enables the eggs to lie comfortably in a nest.

A hen's egg weighs about 2 oz. Thus eight weigh approximately 1 lb. How much would a pound of eggs cost at the current rate being charged for eggs? is a question that may be put. How does this price compare with the price of butter, cheese, beef, etc.?

Experiments on the strength of the egg shell will prove that it can be pressed between finger and thumb along its greatest axis with considerable force without breaking the egg. Less

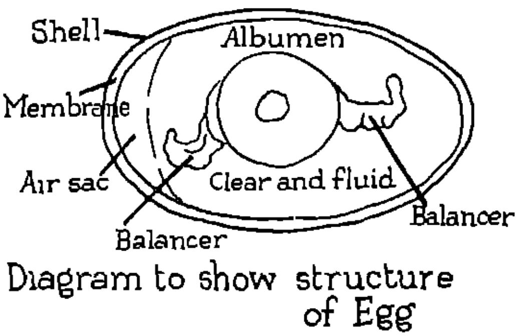


FIG. 64

pressure is required across the egg before breaking takes place. Now tap the shell gently at its broad end and crack the shell. Remove pieces of the shell and allow the children to examine it, describe its thickness and general appearance (of course, children can bring old egg shells for this part of the lesson). Point out the tiny pores through which air can reach the egg (If eggs are to be preserved these pores are closed up. Water glass or lime is used for this purpose. Eggs preserved in this way would never hatch.) Inside the shell is a white skin or membrane At the thick end the membrane is double and encloses an air sac. (The teacher should, of course, draw a diagram as the lesson proceeds.)

Now tip the contents of the egg out into a small glass tumbler. First direct the children to notice the central yolk which is yellow or golden in colour and the surrounding clear liquid which is thick and sticky to the touch To children who have seen inside an egg only after it has been boiled this may come as a surprise. Careful observation will show that the white of the egg is thicker near the yolk. Two peculiar white structures come from the yolk and spread out each side of it into the white. These are the *balancers.* The *yolk* is enclosed in a thin skin. Such a skin suspended in a liquid will always take up the spherical shape. Careful observation of the yolk will show a small patch under the skin lighter in colour. This is the *germ* from which the chicken ultimately develops. The yolk is lightest in the region of this germ and, therefore, the germ is always floating nearest to the side of the egg away from the ground. This is a wise provision of Nature, as the heat from the mothering bird's body will readily reach the developing life germ. *The balancers* which are attached to the yolk act not only in such a way as to hold the yolk in the centre of the egg, but they absorb shocks and prevent too rapid rotation of the yolk, which might be fatal to the life of the embryo chick. Those who have observed the mother hen brooding a clutch of eggs will have seen that she turns the eggs. The mother hen sits on the eggs for a period of twenty-one days, when the little chicks begin to hatch out. They are soon able to run about and peck up food for themselves. This is because the yolk and white of the egg provide a plentiful supply of food for the developing chick when in the egg It thus enters the world with quite a good start.

A Lesson on a Chicken

Young children will be fascinated by such a lesson if the subject of it is present in person in the classroom. It is necessary, however, to warn them to be gentle and quiet in their manner. Young children seldom realize their own strength as compared with tiny bird and animal life, as their treatment of kittens and puppies often shows. If an egg hatching out in an incubator can be shown, the various points about this process can be explained

Nests

This is a subject in which children are keenly interested. It is, however, very necessary for

the teacher to point out the wickedness of destroying or damaging these beautifully constructed homes of the birds.

Birds are not the only creatures that make nests. Some children may have seen the nests of mice; rabbits prepare a nest for their young, the stickleback constructs a nest in the water, bees, wasps, and many other creatures also prepare homes for their young. The most varied and interesting types of nests are, however, made by birds.

From the structure of a bird, as mentioned earlier in this section, scientists think that the bird is related to the reptiles. Many reptiles lay eggs and deposit them in the hot sand to incubate. This is the most primitive form of nesting, so primitive that it can scarcely be called such at all. There are many birds which build simple nests upon the ground More elaborate structures are built by some species in the trees and other places. The more open a bird is to attack by its enemies the more elaborate and secure from destruction will it make its nest.

Nests on the Ground. Some birds make practically no attempt to build a nest. Plovers and terns lay their eggs on the ground. The colouring of the eggs makes their discovery difficult. Specimen cases illustrating this point can be seen in most museums. The young, too, are alert when born and have an instinct which makes them crouch on the ground without movement in the presence of enemies or on hearing an unfamiliar sound. Their colouring, too, is like their surroundings. Game birds make but a little attempt at nest building. The young birds are active from birth. Many waders and divers make nests of a simple type on the ground. The nest of the skylark is loose in texture, but is actually a woven structure. The nest is difficult to find, especially if an attempt is made to find its position from observations of the movements of the parent birds; they alight some distance from the nest and move along the ground to its actual position.

Nests in Holes. Some birds merely make or find a hole and lay eggs in this The owl does this. The kingfisher makes a hole in a bank and puts in the bottom a layer of fish bones! The woodpecker makes or finds a hole in a tree Some birds utilize a hole, but build a nest within it. The sand martin is one such bird.

Nests of sticks can be seen on the tops of trees, built by the rooks and wood pigeons.

Woven nests are made generally by the perching birds. Some of these nests are very intricate and beautiful. The woven nests of the sparrow and robin are masterpieces of ingenuity. The great variety of materials used is astonishing The long-tailed tit builds an elaborate nest on a thorn or furse bush or amongst the ivy. The finches often plaster the outside of their nests with substances to make them match the surroundings. Some birds line their nests with soft material and feathers. The thrush, however, uses a mixture of mud and cow dung. Blackbirds use only mud for a lining

Mud Nests. The common mud or cement nests are those of the swallow and mortin. The swallow's nest is a lined mud nest af an open saucer shape. The martin's nest is built up of clay pellets secured together with a secretion from its mouth. There is an entrance hole, the nest being built close up to the eaves or projections of some kind.

Nest Stealers. Sparrows frequently drive small birds from their nests, whilst the starling steals the nests of swifts and other birds.

The cuckoo makes no nest at all, but lays its eggs in the nests of other birds. When the cuckoo's egg hatches out the young bird takes up the whole nest, and all the time of the foster parents is needed to feed it.

SOME COMMON BRITISH BIRDS

These notes are appended for the use of teachers. They are not meant to be complete nor to be a substitute for information which is better gleaned by observation.

The House Sparrow

This is one of the most common birds seen round houses. The bird belongs to the *finch*

family. In length the sparrow is just over 6 in The brown colouring is well known The male has black markings on throat and head. When on the ground the sparrow hops and occasionally jumps. The flight is direct, the wings move quickly, although the bird flutters and droops at times. The nest built by male and female is untidy and made up of all sorts of material Sometimes it is constructed in a tree, more often on ledges under the eaves of a house. Sparrows sometimes steal other nests or take possession of deserted nests The diet is mixed. Sparrows will eat not only seeds, berries, buds, fruit, and grain but also some insects and spiders. Several broods of young may be reared in a season; from four to seven eggs are hatched at a sitting. The eggs are pale blue in colour and blotched with brown and lilac tints. The sparrow is rather quarrelsome, and has considerable assurance, seeking food from beneath the feet of horses and in crowded streets. The song, or rather call, is a "chirrip"

The Starling

This bird is larger than the sparrow, being some 8 in. long. It is very fond of company, and numbers of these birds are generally seen together Even in the mating season some birds who have not paired up are found in company. In winter large flocks congregate together. They sleep in buildings in the towns or in woods. During the day they fly out in a large flock to the marshy fields, where they obtain worms and larvae. It is quite an imposing sight to see a wheeling flock of starlings. When alarmed they rise together. This is done evidently to frighten any birds of prey. By use of a telescope it becomes evident that the starling is a pretty bird with varied markings—blue-black with a tinge of brown and little specks of buff, pale brown on tips. The female has more spottings than the male, and brown eyes The beak is brown colour in winter and becomes yellow in the breeding season. The starling walks on the ground In the air the flight is strong and alternates between rapid movement of the wings and gliding (*cf.* free-wheeling). The bird can turn and wheel cleverly. When flying in flocks it seems as if the turning and wheeling is done under leadership. The nest is untidy and built of many odd materials. Sometimes the starling steals nests of other birds, driving them out. Starlings eat insects and worms mostly, but they are not averse to cherries, apples, and the like. The eggs are greenish blue and have a rough texture. From four to seven eggs make up one sitting. Like the sparrow, the starling is quarrelsome and noisy. Many people are deceived by the song of the starling as he is a born mimic, imitating phrases of other birds' songs. He has a peculiar alarm note. Starlings can often be seen on sheep's backs searching for maggots.

The Robin

This bird is a great favourite and one of the most easily recognized, by reason of its red breast. It is more nearly a bird of the hedgerow than the house, but as it is so frequent and tame a visitor in winter it is included with those which are found round houses. The bird is brown above, red on the upper breast, and whitish below. Both male and female are alike, and in length about $5\frac{3}{4}$ in. Robins are near relations of the nightingale and the hedge sparrow On the ground robins hop, their flight is strong and direct, though they can hover when watching for insects The nests are built in the bases of hedges on the ground, in ivy, and in other strange places. Insects and worms are eaten as well as berries and fruits Crumbs and household tit-bits are welcomed in winter. The eggs are yellowish white, spotted with brown, and several broods of from five to seven are reared in a season. The robin is another pugnacious bird fighting its own kind. At breeding time the robin is often to be seen puffing up its plumage.

The Martin

Three birds often found in summer, nesting and flying round the houses, are the martin, the swift, and the swallow.

The martin is just over 5 in. long The colouring of both sexes is alike. The bird is blue black in colour on the back, the rump, breast, and underpart are white, whilst the legs are brown (In contrast to the martin, the sand martin is predominantly brown with white chest across

which a band of brown is seen.) The martin arrives in England at the end of April and even later in northern England and southern Scotland. It is rarely seen in Northern Scotland. The flight of the martin is in swift skimming curves, but the curves are not so large as those made by the swallow. The martin does not walk a great deal on the ground, but when it does so walks carefully. The nest is made of mud, with a hole for a doorway. It is often lined with feathers and grass. Five to six eggs make up a sitting. These are white. The male bird not only assists in building the nest and feeding the young, but it also takes turn in sitting on the eggs. The food consists of insects caught on the wing. The song is a throaty warble, and a peculiar sound is made whilst in flight.

The Swallow

The swallow is larger than the martin, being over 7 in. long. It arrives just before the martin. The male swallow is blue-black on the back, whitish underneath, with a reddish brown throat under which is a band of blue-black. The female has a shorter tail and less distinctive colouring on the breast. The swallow is a strong, graceful, swift flier, wheeling and turning on the wing with graceful curves. On the ground the swallow walks with a side to side motion. The nest, which is built against roof timbers and under house gables, is made of mud; it is larger than the martin's and is open. It is lined similarly to the martin's. From four to six eggs make a sitting. The eggs are white but are spotted with a browny tinge of yellow. The food consists of insects taken on the wing. The swallow has a warbling song and an alarm note. The male bird feeds the young but does not sit on the eggs.

The Swift

This is another migrant arriving at the end of April. Both male and female are alike in the colouring of their plumage, which is black. The upper breast is a dirty white. The swift belongs to a different family from the swallow or martin, its four toes being all set forward. It is not a perching bird. It can travel on the ground only with difficulty, and rarely alights except to enter the nest. The nest is built high up in a building or in a hole in a cliff, and is made of straw and feathers cemented together with the bird's saliva. Swifts often nest in colonies. The flight is very swift (practically no bird exceeds it), and generally high. The wings move quickly and there are periods of gliding. The food consists of insects taken on the wing. The call is a scream. The swift is essentially a bird of the air.

The Thrush

Often to be seen in gardens where there are bushes, the thrush is a large bird about 8 in. long. Both sexes are brown on the back and underneath are whitish and spotted with brown. The female is somewhat smaller than the male. The bird is resident in this country but migrates frequently from one part to another The thrush has an undulating flight and its jerky nature does not make it very graceful. On the ground it hops and occasionally runs. The nest is built in thick bushes, frequently in evergreens, though nests have been found on the ground, they are usually above the level of a man's head The nest is made of moss, grass twigs, and similar substances; inside it is plastered with cow dung and mud. Some five eggs are brooded at a time. The eggs are greenish blue splashed with dark brown. The chief food of the thrush consists of insects, worms, and snails, though fruit and berries are also eaten. The thrush frequently has "an anvil" consisting of a stone where it breaks the shells of snails. Quietly standing in a field or garden the thrush listens for movements of worms within the ground. Its pointed beak soon seeks out one near the surface. The father bird assists in feeding the young. The song of the thrush is well known, phrases being repeated twice or thrice. Macgillivray gave the song of the thrush as " qui, qui, qui: kweeu, quip; tiurru, tiurru, chiprivi; tootee, tootee; chiu, choo; chirri chirri chooee quiu, qui, qui." The bird is shy and has an alarm note.

The Missel Thrush is larger than the ordinary song thrush, is lighter in colour, and possesses no sign of yellow. Its song is not so melodious. Its song, however, is heard early in the year,

and the bird is said to sing in stormy weather, hence its name of "Storm Cock."

The Blackbird

How many people realize that it is only the male bird which is black, the female being brown? The blackbird is larger than the thrush, but not so large as the missel thrush. It is about 8 in. in length. The favourite haunts of the blackbird are in shrubberies and hedges and on the edge of woods. The blackbird flies low, and whilst its flight is strong in the open it is apt to be hesitant when on a short flight. Watch a blackbird alight after flight. The tail is perked up. On the ground the bird hops. The nest is built in hedgerows and bushes, and is generally a yard from the ground. It is plastered with mud and lined with grass, etc. Two or more broods of young are reared in a season, and four to six eggs make a clutch. The eggs, a little larger than those of the thrush, are greenish grey in colour, and are marked with light brown. Blackbirds are shy, especially in nesting time, on the approach of man they dart through hedges where possible. The song is deep and mellow. Its alarm note is almost a cackle. The blackbird feeds on worms, insects, snails, and berries, and it is particularly fond of fruit.

The Chaffinch

This bird is often seen in the vicinity of houses and streets. The male is black just over the beak, with a grey head, dark chestnut back, green hind quarters, and a white and brown tail. The wings are white near the shoulders and barred white, black, and yellow. The under colouring is reddish in colour. The female bird is duller in colour, the upper part being dirty brown and the under part a greyish white. The bird is about 6 in. in length. The chaffinch hops on the ground, and has a strong undulating flight in the air though somewhat in jerks. The nest is built in ivy or in a tree cleft or similar place. It is a most beautifully woven mass of moss, dried grass, etc., lined with feathers and hair. Sometimes two broods of young are reared in a season, and from four to five are hatched at a time. The eggs are greyish blue with brown splashes. The call is well known, "Pink, pink," and the song is gay and ringing with variations. Insects are the main food.

The Yellow Hammer

Often seen with numbers of its kind on the hedges in winter, the yellow hammer is almost 7 in. long. As the word yellow in its name implies, the bird is practically yellow, though brown streaks are seen with the yellow. The hen bird is much duller in colour than the male. It has a quick, jerky flight, and hops whilst on the ground. Its nest is built in the bottom of hedges on or near the ground, and sometimes in gorse bushes. Dry grass, moss, roots, and horse-hair compose the nest. Four eggs make a clutch and the male bird helps to build the nest and feed the young as well as sitting upon the eggs. The eggs are whitish grey with scribbling marks of black. The song is quoted as sounding like "a little bit of bread and *no cheese*," and its call or warning note "it-t." Its diet is a mixed one including grain, grasses, berries, fruit, and insects. The original and more correct name for the bird is Yellowbunting; later it was given the name Yellow Ammer. The "h" is usually now prefixed to the second word.

The Nightingale

This well-known songster arrives in England in the middle of April, and is to be found only in the south and east of the country. The first arrivals are the males. The birds leave in September. The nightingale is a bird of the woods, and prefers to be near water of some kind. The colouring of male and female is alike, a dingy brown above, whitish buff underneath. The young are spotted. On the ground the bird hops. The nightingale is not fond of flying very much in the open, but when the bird does take to flight this is strong. The nest is built near the ground or actually in the base of a hedge or amongst undergrowth. It is made of dead leaves and grass finished off with finer materials. Four or five eggs are generally laid in a sitting, and only one brood is reared. The young leave England in August, before the older birds. The egg is olive in colour, and may have a tinge of

brown or green in it. The song of the nightingale is world famous and defies description; the deep "chug chug" at the beginning is typical and the liquidity of the notes is remarkable. Wireless transmissions of the song have made many people familiar with it in recent years The bird sings at night. In a quiet copse, however, the song of the nightingale can often be heard in the day. The singing season is not long. Before many days of June are over the cock has ceased to sing, after which time he makes but a croaking noise. Fruit, berries, insects, and worms form the staple food.

The Rook and the Crow

The rook and the crow are two comparatively large birds that are often confused.

The rook can be distinguished from the crow in two ways. A whitish patch of feathers is seen round the base of the rook's beak, whilst the crow is quite black. Further, the crow pairs up and lives alone with his mate whilst the rook builds in colonies. The rook is about 1 in. less in length than the crow, which is about 20 in. long.

The female rook is somewhat smaller than the male. The colouring of the birds may be described as black with a tinge of green. On the ground the rook walks, moving in a kind of waddle. In the air the flight is strong and steady; the wing movements seem slow, but the pace is often well over 20 miles an hour. The nest is made of sticks and is perched in the fork of a branch near the top of a tall tree. Mud is often used to plaster the nest within and, finally, a softer layer of feathers and sheep's wool is placed. Rooks sometimes nest on rocky ledges. Colonies of the birds live together. There are from three to six eggs in a clutch. The eggs are green with dark spots. The rook feeds on insects, slugs, and worms, and the bird can be seen actively engaged searching for such food in newly ploughed fields. During the autumn months the rook also eats grain, acorns, and similar food. The "caw caw" of the rook is well known, though the bird has many other notes in its repertoire.

The crow is a larger bird than the rook, and mates alone in woods near inland water or near the sea. The nest is built high up in a tree or on a rocky ledge Like those of rooks it is made of sticks, plastered and lined within. Up to six eggs are laid for a brood The eggs are green spotted with brown. The crow is often known as the carrion crow; this indicates that its food consists of decaying meat as well as the food eaten by the rook. Owing to its propensity for taking eggs of game birds the crow is often shot by gamekeepers. It walks on the ground, and its flight is steady but not so easy as that of the rook.

The Cuckoo

Children are always interested in cuckoos. They arrive in April and leave in August. The young leave after the older birds have gone. The peculiar call is eagerly awaited, and people really believe spring has come when the cuckoo comes. The male birds arrive first, and it appears that there are more males than females. The cry "cuck-oo" is the note of the male, the female makes a gurgling or bubbling sound. The cuckoo is hawklike in appearance and flight Its colouring is slatey grey on the back, the wings are spotted with white, and it has a white tip on the tail, barred chest, and buff right below. The female cuckoo lays one egg a week for several weeks, she deposits her eggs in the nests of other birds, and generally in those of small birds. The wagtail, skylark, hedge sparrow, and robin are among the birds which are victimized, for the foster parents' own young are pushed from the nest. The cuckoo lays an egg on the ground and conveys it to a chosen nest in its beak

The cuckoo feeds mostly on caterpillars of the hairy kind, insects, and spiders. It is largely a bird of the air On the ground the bird walks clumsily. In the air the flight is strong and straight. The tail being carried well out behind makes the bird's appearance resemble that of the sparrow hawk. Cuckoos are often attacked by a number of small birds.

INSECT LIFE

MANY interesting lessons on insects can be taken in the Junior School. Of course, it is not possible to do a great deal of detailed work, but the introduction to the tiny creatures will give enthusiasm for study in later years. Many famous scientists have studied insects, amongst whom might be mentioned Lord Avebury and Henri Fabre. Lord Avebury's writings include works on *Ants, Bees, and Wasps*, *On the Senses, Instincts, and Intelligence of Animals*; and *Flowers, Fruits and Leaves* No one can read any of these books without being impressed by the value of careful and recorded observation. Many of the experiments performed by Lord Avebury can be carried out by children. Any teacher who does not know any of the writings of this naturalist is recommended to procure and study some of them. Not only will a new literary treat be experienced, but a great deal of zest and stimulus will be given to the study of plant and insect life on the right lines. Fabre's writings should also be consulted. The work on the bee, delicate, charming, and detailed, will repay study Fabre was a Frenchman who was born at Sainte-Leone, Aveyron, in 1823. When 18 he was in charge of a primary school, and whilst at this work he bought his first book on entomology. Later he became professor of philosophy first at Ajaccio and then at Avignon. Darwin praised his work on insect life very highly. Fabre died in 1915

The Introduction

The study of insects should begin by observations on various forms of insect life. Get the children (1) to watch the habits of ants, (2) to observe the flight of flies, (3) to see how the bees go from flower to flower, (4) to study the differences in the ways in which bees and wasps seek for food, (5) to watch for other forms of insect life such as the hover fly, (6) to observe aphides on rose bushes; and in dozens of ways such as this stimulate interest in the smaller living creatures. Then some more formal lessons can begin.

What is an Insect?

This question is one which naturally arises. The teacher may not deal with it until lessons on some of the common insects have been given, but here the question is more conveniently dealt with first.

It is clear that insects have jointed bodies, but all creatures with jointed bodies are not insects. The crab and the lobster are definitely creatures with jointed bodies: the outer covering is hard or much the same reason that the bones of

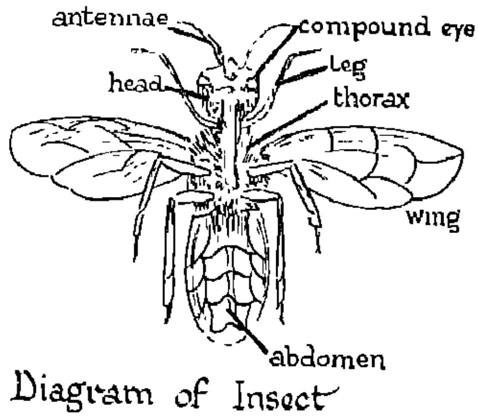


FIG. 65

mammals and some other living things are hard—because they have absorbed mineral matter, spiders have jointed bodies, so have centipedes, but none of these is an insect. All jointed creatures are put in the group called *Arthropods*, and insects form the largest class of such jointed creatures. Here it should be noticed that in mammals the skeleton is bony and the flesh is built up round this bony structure In the arthropods it is as if the skeleton were *outside* (exoskeleton). The insects are divided into *three* parts, each part being quite distinct Examination of an ordinary house-fly or a dragon-fly will clearly show the three parts. (Compare with a spider, which is not an insect) The three parts are named as follows—(*a*) the head, (*b*) the thorax or chest, (*c*) the abdomen.

In beetles it is not often easy to distinguish the junction between the head and thorax.

(*a*) *The head* can move easily and carries (i) the eyes (organs of vision), (ii) the feelers, (iii) the mouth (though this name gives a wrong impression of the structure).

(i) *The eyes* of insects vary somewhat. Usually there are two large *compound* eyes (not always round in shape). Each compound eye is made up of a number of lenses or facets. The actual method of sight must be different from that in man and the mammals where only one lens is found in each eye. Simple eyes are found in some insects, three in a group in the centre of the head near the top

(ii) *The feelers*, or antennae, differ in length and structure from insect to insect They are used mainly as the organs of touch Scientists have found that there are nerves leading from depressions on the feelers as well as from the hair-like structures. It is thought that the feelers may serve some insects as organs of smell and others as organs of hearing, or they may serve as both.

(iii) *The mouth* is generally placed on the under side of the head The structure of the jaws varies according to the work which they have to do. In insects the jaws move from side to side. There are three main parts to a typical insect mouth—the upper lip, the jaws (often made up of *three* sets: (*a*) the *mandibles*, or biting jaws, (*b*) and (*c*) behind the mandibles, the first and second *maxillae*), and the *lower lip*, often an extension of the second maxillae. A study of insects will reveal the fact that the jaws of insects vary considerably. In beetles, locusts, and insects which eat hard substances both the mandibles and maxillae are very sharp and strong. In insects such as the aphides which suck sap from soft plants, the lower lip is modified into a tube (known as a *proboscis*), and within this tube are the jaws developed as piercing instruments. The house-fly has a proboscis somewhat similar in structure. In moths and butterflies a long tube is formed by the junction of two jaws, and with this nectar is obtained from flowers

(*b*) *The Thorax* is the middle section of an insect, and is made up of three segments. Two legs arise from each segment. The typical insect thus has *six* legs, but these are jointed differently in different insects. The legs terminate in claws or pads. The wings of those insects which possess them also grow from the thorax. It is noteworthy that insects are divided into orders very largely according to variations in their wing structures. Without giving the technical names the following are the chief divisions—

1. Wingless
2. Half winged—aphides
3. Two wings—flies.
4. Straight wings (4)—grasshoppers
5. Net wings—dragon-fly
6. Scale wings—butterfly
7. Membrane wings—bees
8. Sheath wings—beetles
9. Fringe wings—tiny insects found in flowers

In discussing birds it was mentioned that their wings were modifications of the upper limbs. In insects the wings grow from the body itself.

(*c*) *The abdomen* consists of a number of segments. No limbs or other appendages are found growing from the abdomen Contained within it are the primitive heart and the sex organs. Devices for piercing substances in which to deposit eggs and the sting are found in the abdomen in those insects which possess either or both of these types of organ.

The internal organs of insects are very much more simplified than those of, say, mammals and birds. Examination of the sections of the thorax and abdomen will show little holes between the sections, called *spiracles* These lead into tubes which form an air system throughout the body. The tubes have walls strong enough to prevent collapse. In human beings air is drawn into the lungs by expanding them, and on contraction some of the air is driven out again. Whilst the air is within the body oxygen of the air is absorbed and carbon dioxide is given up. The oxygen enters into chemical action within the body, oxidizes the digested food, gives heat and energy, and in many ways stimulates and maintains life Insects need the same primal process. Oxygen is, therefore, introduced into their bodies, but not as in human beings though the work done is very similar.

Each insect has special apparatus for digesting its food. In some insects there is a kind of crop, in others a grinding gizzard. The lower part of the alimentary canal absorbs the digested food into the system, and waste matter is expelled at the end.

All insects have *nerves*. These extend from the head through the thorax to the abdomen. Along the central nervous system these are swollen at various points, usually at segments. From these centres other nerves branch off to other parts of the body.

In human beings the blood is carried round the body through a complicated system of veins and arteries, pumped by a muscular and highly specialized heart. The heart in insects is a long organ extending along the central line of the body. The blood is colourless, and is not confined to blood vessels. The rate of blood movement varies with temperature.

Life Cycle of Insects

The changes through which an insect passes from the egg until it is an adult insect provide matter for many lessons. In the study of the moth and butterfly these changes will be examined closely.

1. The egg is laid by the female. It may be carried in a special case at the end of the abdomen for some time, with many other eggs, to be deposited when a favourable spot is found; or the egg may be laid directly on to the under side of a leaf.

2. After some time the egg hatches out. The tiny creature which emerges is known as the *larva*. The chief business of the larva is to eat and grow. The coat is often split, and cast several times during this stage.

3. When the larva is full grown changes begin to appear In some sheltered place it starts to spin a cocoon, a new and harder skin is formed, round the larva, and while the creature lies seemingly dead within its case the greatest changes develop. This is known as the *pupa* stage.

4. Within the cocoon the internal organs of the insect undergo changes, and after some time, varying in length according to the type of insect, a perfect *imago* or insect emerges from the pupa case.

This fourfold change is known as *metamorphosis*. All insects do not undergo complete metamorphosis. Earwigs, bugs, and cockroaches are three types of insects which do not go through this complete cycle. The dragon-fly and mosquito are two insects in which part of the cycle is spent in water.

Apparatus Required

As it is easy to discover *eggs* of insects, it is possible to watch the various changes which take place from egg to insect. Some apparatus can be cheaply provided for this—

1. Breeding cages. These are simply boxes about 20 in. long, 9 in. high, and 8 in. wide One side should be removed, and fine wire gauze or perforated zinc should be fitted. Either of these can be bought cut to size, and can be nailed on. If possible a side of glass makes observation easy. Now, as the eggs are frequently laid on leaves and then larvae that hatch feed on these leaves, arrangements must be made for similar leaves to be placed inside the breeding cages; jam jars filled with wet sand are very suitable containers for them. If water is placed in a jar then the mouth must be covered over or the insects will fall in. It is a great convenience if a tin lid or zinc tray to fit the breeding box can be obtained, as some of the larvae turn into pupae just under the soil. Leaves should be frequently changed so that decay is prevented.

2. Muslin bags Another very interesting method of observing the changes in insects is by means of muslin bags. These are made from fine butter muslin, and have an adjustable tape fitted at each end so that the bag when open is really a hollow cylinder of muslin. Care must be taken to cultivate in the school garden such plants as are known to be suitable food for certain larvae. These larvae are then sought out, brought back to school, and placed on the proper plant A muslin bag is then slipped over the plant or the branch on which the caterpillar or larva has been placed, and the ends of the bag are drawn tightly together. Thus the caterpillar can feed freely in natural conditions but cannot escape

3. It is necessary sometimes to kill insects for examination. This should be done only when absolutely necessary, and it is recommended that the teacher alone should do it then, and not in the presence of children.

Butterflies and moths are killed instantly if placed within a killing bottle which can be

obtained from a chemist. The chemical generally used is potassium cyanide, a most deadly poison. The bottle should be handled with care and kept under lock and key. Death is caused to insects, but not so rapidly, by placing them in a small bottle with pounded laurel leaves. Caterpillars are killed in contact with methylated spirit or ether. They can be preserved in small tubes of alcohol firmly sealed. Care must be taken in doing this as alcohol is very inflammable. The pupa can be killed by dipping momentarily in boiling water.

BEES AND WASPS

Children are always interested in the doings of the bees. Most of them are aware that honey is obtained from the hives of bees. No Nature course in the Junior School would be complete without some lessons on these insects.

Classes of Bees

All bees are included in the order of membrane winged insects. Many people know something of the habits of the honey-bee, but it is just as well to point out that there are quite a number of bees just as interesting to study as this popular bee. Before going on to describe the honey-bee a few notes on other types of bees will be given—

The Humble-bee is perhaps fairly well known. The humble-bee is larger in size than the honey-bee, and is covered with thick hair. This bee is found in most of the temperate and sub-tropical countries of the world. Like the honey-bee, the humble-bee has a social instinct and lives in communities. These communities are comparatively small, rarely exceeding several hundreds in number, whilst in some species they have less than one hundred members. The colony is established by one female, a queen (or fertile female). The nest is made in a hole in the ground, maybe in the deserted home of a mouse or in some corner secluded and moss covered. The cells built are irregular, and a number of eggs are sealed in. The larvae which hatch out find their way into a heaped mass of pollen and honey which the mother bee has collected. For her own use she keeps a little store of pure honey which she has obtained.

In due time the larvae become pupae, and then emerge as baby bees. These as they grow become workers and fetch pollen and honey for further batches of young bees. Later, eggs which hatch into male bees are laid by some of the workers. At the approach of cold and frost most of the bees die, some of the fertilized female bees crawl into shelter for seclusion and warmth. Those that survive carry on the species in the same cycle.

The Cuckoo-bee is rightly named, for it does not make a nest of its own. Its eggs are laid generally amongst those of the humble-bees. It is interesting to notice that the cuckoo-bee has no pollen baskets on its legs. The humble-bee has.

Solitary Bees. These are quiet bees who live in solitude and who do not make hives as the honey- and humble-bees do.

The Leaf-cutting Bee. Frequently it can be noticed that the leaves of a rose tree have circular pieces removed from them. The question naturally arises as to how these pieces have been cut out. Careful observation will prove that it is the work of a kind of bee. The insect is black and has a patch of white on its head, some segments of the abdomen are also streaked with white. The nest is a small tunnel in the earth. First the tunnel is driven, say, 1 in. vertically and then it is continued horizontally. When the soil is hard and firm then the bee goes forth to seek the lining. The pieces of leaves are cut so that when rolled they fit into the tunnel. When about $\frac{1}{2}$ to $\frac{1}{3}$ of an inch is lined the bee puts in a cake of honey and pollen, and then lays one egg. On top several circular pieces of leaf are placed. The bee then makes another tiny tube just fitting in the first. Honey, pollen, and an egg are again put in and another cover is placed on top. So the tunnel is filled up with seven, eight, or more little cells. This bee is indeed a great worker and a most clever and ingenious creature.

The Carpenter Bee is not found in the British Isles but in South Europe and the more southerly parts of Germany. It is something like a

large humble-bee, but darker in colour. The female bores with her powerful jaws sideways into a dead tree or old post. When an inch or two in length, the tunnel is made to turn at right angles and traverse the length of the wood. Tunnels of over a foot in length have been found. Little cells are formed in the tunnel, partitions being made of sawdust moistened by a special liquid made by the bee. In each cell food is placed and an egg laid.

The Mason Bee constructs cells against a wall or rock. The cells are made of sand, soil, and earth mixed together with saliva into a mortar. Honey is first deposited in the cell, then pollen from the legs; finally an egg is laid. A group of seven to ten cells is made, and then the whole is plastered over. Mason bees sometimes use old cells from which larvae have emerged in a previous season. The cells are repaired and made sanitary and habitable.

The Poppy Bee is so called because it lines its nests with poppy petals

Honey-bees

These bees are, of course, a community species. Through long ages man has preserved this bee by providing hives or homes for it. The honey which it stores is removed to serve as food of man. To understand life in a hive it is first necessary to know something of the types and work of the inhabitants. There are three classes of bees in the hive—

1. *The Queen Bee.* She is the only fertile female within the hive, and thus the continuance of the community depends upon the hatching of eggs which she alone can lay. The queen bee is the largest bee within the hive. There are no pollen baskets on her legs or wax pockets on her abdomen. She is *not* a worker but a queen. Her colouring is somewhat different from that of the other bees, her underside being yellowish.

2. *The Workers* are sterile females. They keep the hive clean, build the cells, feed the babies, fetch the nectar, pollen, and wax, manufacture the various kinds of food, ventilate the hive by flapping their wings, and generally maintain an efficient household. Their lives are not long. A worker rarely lives more than a few weeks—six at most. Of course, at the end of the summer many workers then alive live through the winter in the hive ready to begin the work of tending the young again.

3. *The Drones* are the male members of the community. These do no work but feed on honey provided by the workers. Their only function is to fertilize a queen bee. The drones are larger than workers; they are lazy, and spend much of their time in useless visits to flowers, where they loiter. The drones do not live long, the workers eventually killing them.

In order to explain what happens in a hive

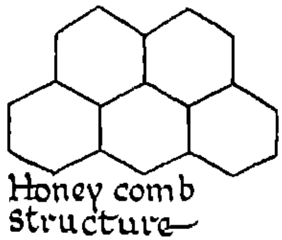


FIG. 66

it is well to describe the events from spring until autumn—

1. As spring begins to come a peep in the hive would reveal—

(*a*) a queen bee,

(*b*) a number of worker bees.

2. With sunshine and warmth the sleepiness of winter is thrown off—

(i) The workers fly out in search of pollen and nectar, the products of flowers.

(ii) They clean up the hive, casting out dirt, decayed matter which would probably have been waxed over, and dead bodies of any bees which have not been able to survive the winter.

(iii) They hang in a bunch from the top of the hive and secrete wax.

(iv) With the legs they remove this wax from the pockets on the abdomen, and chew it within the mouth to soften it

(v) Comb builders begin to use the wax to construct the familiar six-sided wax cells. The first cells made are really nurseries in which the eggs are to be laid and hatched. The cells are of three sizes: (*a*) the smallest, worker cells, (*b*) larger ones for drones, (*c*) still larger cup-shaped cells, few in number, in which the baby

queens will be reared—these last are not built at first.

3. When a number of brood cells are made the queen bee passes over them, accompanied by a number of workers. In each cell she lays one egg. The eggs are long, oval, and almost white in colour. The watchful workers remove any eggs in excess of one laid in each cell, and place food within each cell. Some idea of the work of the queen can be gathered from the fact that she may lay 3,000 eggs in one day. Study of the order in which hatching takes place suggests that (*a*) workers are first hatched, (*b*) then drones, (*c*) then queen bees.

4. The feeding of the growing family is an arduous task. The workers hatch out from their eggs in three or four days, the larvae are fed for a few days on food which has been predigested by the workers, and for the remainder of their larval state on undigested food. The cell is then sealed up and within three weeks of the laying of the egg a perfect bee emerges from the pupa. Soon the young worker is busy gathering pollen and nectar. The older workers generally tend the hive. The baby queens are fed on the predigested food in a special form called royal jelly.

5. *Swarming.* The rearing of numbers of workers and drones has naturally increased the population of the hive, and conditions are not so comfortable. But another circumstance has to be reckoned with which makes the queen bee somewhat restive. The baby queens imprisoned in their large wax cells are almost large enough and sufficiently developed to be released and take up their positions as queens of hives. It may be that, knowing her dethronement may be at hand, the queen decides to go away and establish a new home with some of her faithful followers. If this is the case, one morning, when the excitement in the hive is intense, off she flies. Swarming round her are faithful workers. The queen does not fly far. The swarm settle round her where she alights, hanging from a branch in a long black bunch. Bee-keepers watch for such a swarm and sweep it into a new hive. In the wild state the bees find a hollow in a tree, or a hole in an old wall, or an old tower in which to make a home. Here begins the building of brood chambers and later of honey cells to store food for winter.

Meanwhile back in the old hive the remaining workers release the princesses, who at once fight for the queenship. Having killed her rivals the remaining princess becomes indeed the queen. Sometimes a baby queen will emerge whilst the old queen is still in residence. It is, however, the old queen who leaves the hive with the first swarm. She may kill the first baby princess and so put off the evil day.

The new queen must now go out on her nuptial flight. One fine morning she leaves the hive pursued by a large batch of drones. High up in the air mating takes place between the queen and one of the drones. He is one of the strongest for all the others have been left behind in the swift high flight of the queen. Some naturalists suggest that fertilization of the queen takes place with a drone from another hive.

The new queen returns and the work of increasing the population of the hive begins again. In addition stores of honey are made ready for winter feeding. The drones are driven into a corner, partly starved, and then with bitten wings hustled from the hive to die.

Bee-keeping

Some insects are the foes of man. The bee, however, is capable of supplying him with *food* as well as *wax* which is useful for many purposes.

The hives which are now provided for bees are scientifically constructed so that it is quite easy to procure the honey. Originally hives were simply dome-shaped hollow structures made of woven straw. These were called *skeps*. To get the honey, men had to kill or stupefy the bees by smoking out the hives with the fumes of burning sulphur. Modern hives are constructed of sections of wood. Each section is in shape like a box with no top or bottom. Arrangements are made so that the upper section will fit exactly on to the one beneath and fasten securely. Any number of sections could be used. The top section is finished off with a roof. In these sections vertical frames are slotted in. These frames in the lower section or sections form the brood chambers, where the eggs are laid and the young are reared. Dividing the lower sections from the upper is a perforated zinc sheet.

The openings in this sheet are so arranged that the smaller workers can enter the top of the hive whilst the queen cannot pass. Thus all sections in the upper part of the hive are filled with honey. Frequently square sections are placed there, and to save the energy of the bees the of the cells and places the section in a patent machine. This machine when working whirls the section round rapidly and the honey is flung out of the cells. Such honey is called run honey. The wax is melted down and is known as beeswax.

FIG. 67

Bee-keeping in Australia

Notice the extra hives made for new swarms from petrol boxes thus do pioneers overcome difficulties

cells are ready-made The bees need then only make honey.

When all these sections are full the bee-keeper with his head and hands protected by a veil puffs smoke into the hive to stupefy the bees temporarily. He then opens the hive, removes the full sections, and puts in more empty ones. The sections are sold complete as *comb-honey*. Honey is also extracted from combs by the bee-keeper. He breaks the surface

Bee-keepers watch for swarms and pursue them, as a swarm may be very valuable. The swarm does not travel far generally, but no bee-keeper can be summonsed for trespass when in pursuit of a swarm from one of his hives. The swarm when found is generally shaken into a skep and taken back to the garden, where the hives are If the swarm is shaken out on to a white sheet in front of an empty hive it is not often long before the bees will enter and

found another bee community. An old rhyme says—

A swarm of bees in May
Is worth a load of hay.
A swarm of bees in June
Is worth a silver spoon
A swarm of bees in July
Isn't worth a fly

This indicates the fact that early swarms have time to settle down and collect honey to the

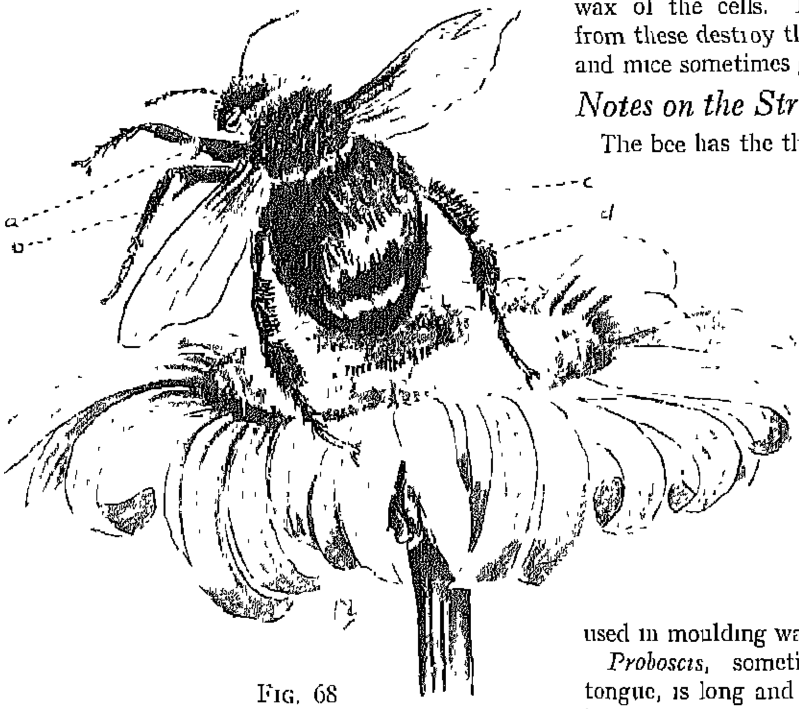


FIG. 68

The Humble-bee
(a) Comb. (b) Prong for digging out pollen. (c) "Pollen basket." (d) Brush.

profit of the bee-keeper. Later swarms cannot do this, and may even need feeding

As can be imagined, if the bee-keeper takes away the honey which the bees have stored for winter food then he must provide other food for them. This he does in the form of syrup made from cane sugar The food he supplies does not cost him as much as the value of the honey which the bees have yielded

Honey is not all of the same flavour. This flavour depends upon the kind of flowers from which the bees obtain the nectar Honey from nectar obtained from *heather* is considered very choice. Lime blossoms provide another good source, as does the gorse. Certain flowers are favoured by the bees because of their structure, colour, and nectar; bee-keepers often grow these, or place the hives in their vicinity.

Bees suffer from several diseases—dysentery, Isle of Wight disease, and foul brood are three of the chief A moth (the wax moth) does damage in the hive by laying its eggs in the wax of the cells. The larvae which develop from these destroy the cells. Blue tits eat bees, and mice sometimes get into a hive.

Notes on the Structure of the Bee

The bee has the three definite divisions of all insects. There are four wings, all net-veined, the two rear wings being smaller than the front ones. In flight the smaller wings are attached to the front wings by hooked attachments. The worker might be especially described—

Feelers, probably used for communication.

Two compound eyes—three small eyes in centre of head.

Two jaws or mandibles used in moulding wax, etc.

Proboscis, sometimes incorrectly called a tongue, is long and hollow, and used for sucking up the nectar of flowers. The proboscis is formed from lower lip and inner soft jaws.

The nectar is passed through the proboscis into the honey bag, where it undergoes certain changes and is then poured out as *honey*

Legs, three pairs, with claw-like ends for clinging: front pair provided with type of comb used for cleaning purposes, middle pair are adapted for digging out pollen, hind pair have "pollen baskets."

Sting. The end of abdomen is protected by a sheath and is connected with poison duct. The sting is barbed For this reason the sting is left in the wound and the bee dies because

of the rupture of its body caused by the tearing out of the sting.

Read *The Life of the Bee* by Maurice Maeterlinck, written in 1901. Maeterlinck is a Belgian poet, and many teachers will know his fairy play *The Blue Bird*.

Exercises: 1. Watch the flight of a bee from flower to flower. Notice which flowers it visits. Does it visit only flowers of the same kind on each journey? What differences can be noted in its flight from flower to flower and on its return journey?

2. Watch a humble-bee. Notice the differences between its habits and those of the honey-bee. Try to find one making its toilet.

3. Model cells in plasticine. Discuss the wonder of the regular six-sided cells (hexagon shaped). Model or draw other shapes and notice the ease with which hexagons fit together and how no space is wasted.

4. Model skep hives and modern hives. Notice shopkeepers who sell hives. they generally have tiny models of hives which they are willing to lend to schools.

Wasps

Children readily recognize the black and yellow striped wasp. They are generally frightened of it. A talk on the wasp and its habits should be given to Juniors, for understanding will lessen or destroy fear. The chief facts about wasps may be shortly stated—

1 There are several kinds of wasps. The hornet may be classed as one, but of the common wasps in Britain there are seven or perhaps eight kinds.

2. These common wasps are social in habits, build nests, and have three types in each—queen, workers, and drones.

3. The race survives through the hibernating sleep of *queens*. Thus the destruction of *queen* wasps found asleep in late autumn, winter, and early spring is important.

4. On awakening from sleep the queen makes a hole for the nest. The nest is made of a kind of paper manufactured by the queen from wood scraped from trees, posts, etc., and mixed with saliva. Watch for a wasp doing this in spring. The cells are cup-shaped, and eggs are *fastened* to each cell. The eggs go through the stages of larvae and pupae before becoming full-grown wasps.

5. The home is made larger as the season progresses.

6 Wasps feed not only on nectar but also on meat or garbage. Fruit is a favourite dish, but wasps also kill a number of insect pests.

7. Queen wasps are reared last. The young queens do not quarrel with the old queen.

8. Food is not stored. After mating the nest is neglected, and many young are allowed to die. Then the queens hibernate and the others die.

9. The wasp stings only when attacked, but pluckily pursues an adversary.

10. Wasps do considerable damage to fruit, etc., and for this and other reasons they are probably best destroyed as pests.

11. Wasps have marked divisions (wasp waisted), and fold their wings lengthwise.

BUTTERFLIES AND MOTHS

Butterflies are favourites with children. The colouring of the wings and the flight of these insects both attract attention From the point of a Nature Study syllabus, however, the butterfly has other qualifications for inclusion in a course. In this insect the changes through egg, larva, pupa, and complete imago stages can be most easily observed. If for no other reason the teacher of Nature study should include some lessons on butterflies. With some of the apparatus described earlier it is possible in both town and country to watch the development of these insects.

Structure of the Butterfly

If a butterfly is caught and killed in a killing bottle its structure can be observed. A Cabbage White butterfly may well serve such a purpose.

The butterfly is definitely an insect, and has the well defined head, thorax, and abdomen.

(*a*) *The Head.* No jaws worth noting, the

proboscis has developed instead. This is the organ by which the butterfly sucks nectar from flowers; when not in use it is coiled up (try to observe a butterfly unrolling this proboscis). There are two large compound eyes. The three smaller eyes are present only in a few butterflies. The antennae have knob-like ends, and this fact serves in the British Isles as an easy method of distinguishing butterflies from moths, the antennae of the latter being feathery. These are the centres of smell and touch. If the antennae are destroyed a butterfly is unable to regulate its flight.

(b) *The Thorax.* Six legs are attached. Watch a butterfly alight. Many varieties use only the four back legs when on the ground. Notice that the two front legs are often shorter and carried against the thorax. The ends of the legs are jointed. Observation will show differences in the leg endings in various types of butterfly. Butterflies are classified largely by their feet, but this cannot be discussed here.

There are four wings, and the movements of these are controlled by expansion and contraction of the chest. When folded the wings are closed vertically and thus the underwings are shown (moths generally show the upper pair, which are closed over the lower). Both butterflies and moths have scale wings (hence the name lepidoptera); these scales rub off when touched. The breathing, nervous, and digestive systems are similar to those described for insects generally.

3. The abdomen is elongated but does not call for any comment except that the reproductory organs, excretory organs, and muscles make up this part of the body.

The teacher would do well to obtain some butterfly's eggs and rear them in a cage.

Eggs

Butterflies' eggs are usually laid on the undersides of leaves. By some instinct the parent deposits the eggs singly or in colonies on plants which will provide food for the caterpillars that will develop from the eggs. Search will generally reveal eggs which can be secured for school observation work. Do not pick the eggs off but take the leaf or spray on which they are found. The eggs should be observed through a magnifying glass and drawings made of their shapes. Many beautiful patterns can be observed. Some moths lay their eggs on twigs. Other butterflies and moths lay their eggs on any material without apparent selection or thought. One of the most common for school observation is the common cabbage butterfly. The eggs are golden yellow and can be found on the underside of the leaves of the cabbage and other plants of the cabbage family

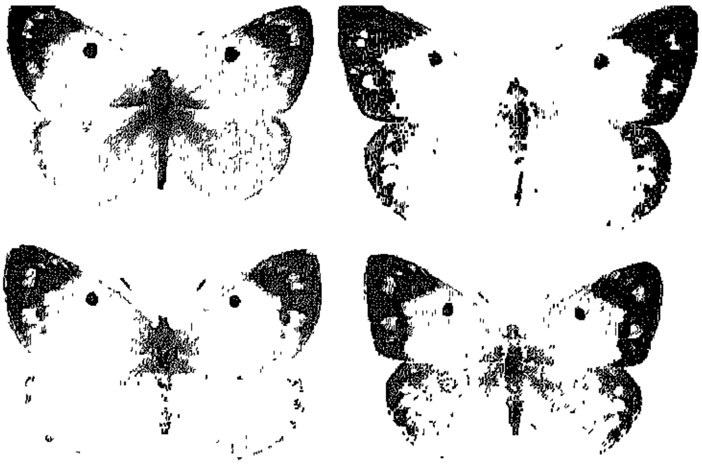
Caterpillars

From the eggs hatch out caterpillars. The tiny creatures eat enormously and grow quickly. The presence of caterpillars on a plant is often first shown by the signs of leaf destruction The caterpillar is worm-like and has a head and a body on which there are a number of legs. The front six are the true legs, and correspond to the ultimate six legs which the perfect insect will have. There are other temporary legs. This examination and description of the legs will provide observational work. Attachments for climbing may often be observed. Caterpillars walk in different ways. These should be observed. The "looper" caterpillar, for example, seizes objects with the front legs and draws the two temporary legs almost up to these, thus looping his body. The jaws are very powerful, and the head is strong; there are traces of antennae. As growth proceeds caterpillars cast their coats

A very interesting study is that of the colouring of caterpillars. Some are very like the leaves or twigs on which they live. the stick caterpillar is a good example. Such an instance of protective colouring may lead to a talk on other protective colours, e.g. lions in the desert, tigers in bamboo, chameleons, etc.

Some caterpillars though bright and gaudy expose themselves freely: these are found to have a taste unpleasant to birds. Experiments with chickens will prove that after tasting one unpleasant caterpillar they will reject those of like colouring. The caterpillar of the magpie moth, which is found on currant bushes, is one of this type.

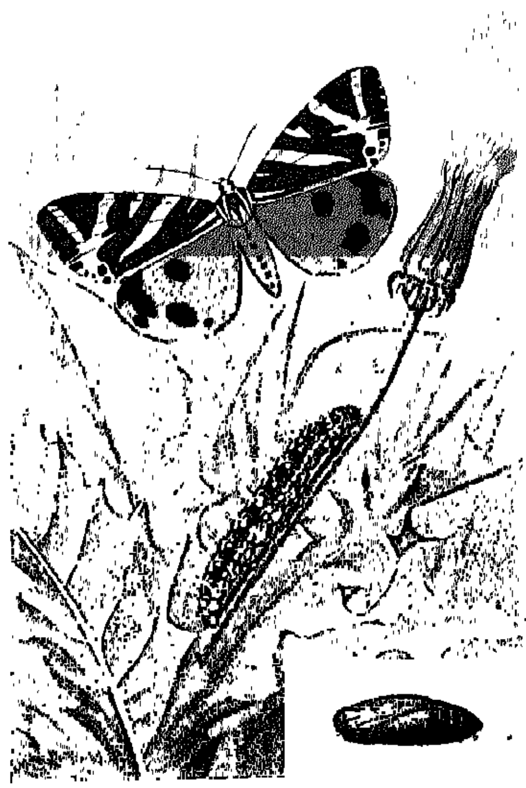
Notice here that caterpillars which feed at



CLOUDED YELLOW BUTTERFLIES
Natural size

Natural Size

PURPLE EMPEROR BUTTERFLY
Egg, caterpillar, chrysalis, and perfect insect (male)



Natural Size

JERSEY TIGER MOTH
Eggs, larva, chrysalis ([illegible]), and perfect insect

PLATE IV
BRITISH BUTTERFLIES AND MOTHS

By courtesy of BRITISH MUSEUM (NATURAL HISTORY)

times this coat changing will take place, and the caterpillar will grow bigger and bigger.

8. When the fifth coat change might be expected the caterpillar begins to eat less but is not so listless. Wandering round it looks for a stick or a projection. This indicates that the time has come for not a change of coat but a change of state. The pupa stage is about to begin

9. Make a number of paper bags in the shape of cones, that is, like the sweet bags often supplied in shops Place a caterpillar which is ready in each of these and pin up to the side of the cage.

10. Spinning will begin and soon the caterpillar will be shrouded in a beautiful silk cocoon. When the cocoons are complete, silk producers bake the cocoons or treat them so that the pupa is killed The silk is then obtained from the cocoon.

11. Leave the cocoons in the cage. Some fifteen days after the cocoons are fully made some of the moths will be ready to come out. They will bite their way through the silk and emerge as yellowish white moths barred with indistinct lines of darker colour.

12. Mating may take place between a male and female moth, and eggs may be laid which will be fertile. Their fertility, of course, will be tested by whether or not they hatch.

Some Butterflies and Moths to be Observed

Butterfly	Food of Caterpillar	Perfect Insect Seen	Moth	Food of Caterpillar	Perfect Insect Seen
Large white	cabbage	June–Aug.	Eyed Hawk	poplar, willow, apple	late Summer
Red Admiral	nettle	,,	Death's Head Hawk	potato	June
Peacock	,,	July–Aug	Convolvulus Hawk	convolvulus	June
Brimstone	buckthorn	Spring, Autumn	Magpie	gooseberry, currant	July, Aug.
Tortoiseshell	nettle	June–Sept			
Common blue	wild strawberry and grasses	June–Aug	Tiger	many garden plants	all Summer

SPIDERS

The spider should not be included in a section devoted to insects. A note or two on this creature will not, however, be out of place, as it will emphasize the reason for its non-inclusion as an insect.

The garden spider may be taken as a typical spider. It belongs to the jointed-foot animals (*cf.* insects), but is in the *arachnid* class. The body has two parts—

(*a*) The head and breast united in one part.

(*b*) The abdomen.

The head has two pairs of appendages—

(*a*) One pair, used for seizing its prey, with peculiarly jointed ends and poison fangs.

(*b*) One pair used as feelers.

The mouth is small and placed on the underside of the head. There are eight eyes with single facets.

Below the head on the part corresponding to the thorax are four pairs of legs. Each leg is tipped with a special claw-like device which enables the spider to cling to surfaces over which it desires to walk Interest in spiders is increased when their webs are examined. The silk used in making these webs is manufactured in special spinnerets which are situated at the end of the abdomen The silk is forced out of the spinnerets by contraction of those organs. Numbers of spinning tubes, many hundreds in fact, are enclosed within each spinneret. Several kinds of silk can be woven, and some wet and some dry according to the need of the spider. The five strands coalesce together to form stronger threads, and the silk is manufactured by the hind legs of the spider The garden spider builds a most beautiful web, in which it hopes to entrap flies and other insects for food.

ANIMAL LIFE

CERTAIN animals come within the child's environment, and it is necessary to include some lessons on these in the Nature course. The lessons will, of course, deal only very simply with the structure of the various animals, and the notes included here are intended to offer some guide as to the methods of treatment.

The animals which should be described in the course can be divided into three groups—

1. Domestic animals—these include the cow, sheep, pig, horse, dog, and cat

2 Wild animals of the countryside—here, talks on the rabbit, fox, stoat, weasel, and badger might be given.

3 Typical animals of other countries: (*a*) Carnivorous types such as the lion, tiger, and leopard, (*b*) herbivorous types such as the deer, bison, and buffalo; (*c*) other interesting animals; here the selection is very wide, and might include the elephant, the giraffe, and the kangaroo.

These lessons will, of course, be mainly descriptive, and will be illustrated mainly with pictures (see PRACTICAL JUNIOR TEACHER Animal Charts). Visits to a zoo can also be arranged in some cases. The lessons should be linked up with the geography course.

DOMESTIC ANIMALS

The word "domestic" is derived from a Latin word *domus*—a house. This explains of itself that domestic animals are those which belong to the house or home, that is, they are animals that live with or near man, and are his especial concern. (Incidentally, why is a word which comes from the Latin found in the English language? Such things are worth mentioning sometimes.) The domestic animals are kept by man for several reasons—

1. As friends and pets, e.g. the cat and dog.
2. As protectors, e.g. the dog.
3. As suppliers of milk, e.g. the cow and goat, etc.
4. As suppliers of food, e.g. the pig, sheep, bullock, etc.
5. As beasts of burden, e g the horse, mule, donkey, camel, etc

The Cow

Cows are kept chiefly for their milk, but the flesh also is eaten by man. Get the children to describe the appearance of a cow—the shape of the body, the shape of the head, the position of eyes, ears, and horns. Notice that there are various kinds of cows. Pictures of cattle can be obtained from a weekly paper such as the *Farmer and Stockbreeder*. Cattle-cake dealers and vendors of patent cattle foods will also supply attractive pictures for class use. These can be used in composition lessons. The shape of the legs and feet should be noticed and the hoofs are especially interesting. The horns of the cow are hollow. Those of the deer family are solid and are shed annually.

The cow eats only vegetable food, that is, it is a vegetarian. The grass or hay upon which it feeds is pulled off by its teeth, with the assistance of its tongue, and is swallowed. The food is quickly eaten and stored in the first stomach. When this stomach is full or the cow has no immediate further opportunity to gather more food it lies down. The food then passes from the first to the second stomach, from whence it passes back to the mouth to be chewed. Most children will have seen a cow chewing the cud The food is then swallowed and passes through a third stomach, and finally is digested in the fourth stomach. It is interesting to notice that animals which chew the cud in the wild state have to swallow food rapidly, and then often run from their enemies. Thus they are so constituted that the digestive and even chewing process can be done later in quietness.

Milk which is obtained from the cow is a

perfect food. Although nearly $\frac{9}{10}$ths of it consists of water all the main groups of food are present in it. As milk easily becomes contaminated with germs of disease special care must be taken to keep it clean. The three main grades of milk are Tuberculin Tested (Sterilized), Tuberculin Tested (Pasteurized), and Accredited. For details see H M.S.O. leaflets No 1589 and 1590, 1950

In town schools especially a talk on the way in which milk reaches the home might be given:

(a) milking the cows, (b) cooling the milk, (c) placing it in large cans, (d) transport—rail or road, (e) the milkman, (f) bottled milk.

Many valuable bi-products are obtained from the carcass of the cow—leather from the hides, horn for knife handles, etc., from the horns, glue from the hoofs, artificial manure from the bones, sausage skins from the intestines, etc.

The Sheep

Sheep are kept for their wool and for their flesh. Children will have seen loads of frozen mutton being delivered at butchers' shops in the cities. This will serve as a link with a geography lesson.

Wild sheep are still found in some parts of the world. These are mostly horned and have short tails. Many domestic sheep are unhorned—the females generally are without horns—and the tails are long. Sheep are kept in flocks and feed on grassland. The lower slopes of mountains and the uplands are the chief homes The country child will have splendid opportunities of watching sheep and of seeing how nimble the lambs are in springtime. Sheep are herbivorous. Soon after the middle of May shearing begins, and the long woolly coat which has kept the sheep warm in winter is clipped off and sold. The fleece, as it is called, must be cleaned, combed, spun, and woven before it is useful as clothing to man

Kodak Snapshot

FIG. 69

Sheep in the Peak District, Derbyshire

The grass downs of the world provide pasture for sheep

The Pig

Pigs are not very attractive animals as kept in the average pigsty, though when kept in the open and in woodlands they are not so unpleasant, and may even develop habits of energy and strength. The wild pig can be dangerous to man.

The pig has cloven hoofs. The shape of its head, with the pointed snout which is supported by a special bone not found in other hoofed creatures, is typical of the pig family

The pig is supplied with tusks in both jaws though in some kinds these are not very prominent. The tusks in the upper jaw point upward. There are four toes on each foot: only the middle two touch the ground in walking. Pigs have only one stomach and do not, therefore, chew the cud. The coat is covered with bristles Practically the only use made of the pig is for food. When uncured the flesh is known as pork, when cured it is called bacon. The pig will eat flesh as well as a vegetable diet.

The Horse

The horse is the chief beast of burden in the British Isles. The Red Indian and Arab were always proud of the noble steeds which carried them in the chase, in warfare, and in more peaceful pursuits The horse unlike the cattle previously described, stands on *one* toe Originally the ancestors of the horse had *five* toes two have now disappeared, and the remains of the other two toes are seen in two splint bones found near the fetlock Wild horses are still found in Mongolia. Other wild horses have originated from those who have escaped from domesticity. The food of the horse is entirely vegetable. Horses have been bred by man for various purposes. The strong, slow-moving cart horse, the high-stepping carriage horse, and the agile graceful race-horse can all be observed. In the country the hunter can be seen—speedy, sure-footed, and a good jumper

The Dog

The dog is essentially a friend of man. Through long ages the dog has learned to love, respect, and live with human beings. Dogs can be trained to attack burglars, retrieve game, round up sheep and cattle, and guard property. Nevertheless their chief function is to act as a companion to man. Dogs are naturally flesh-eating mammals and, therefore, need a considerable amount of meat in their diet. Their teeth are especially made to tear meat, the pointed *canine* teeth particularly prominent Dogs walk on their toes and cannot withdraw their claws into the paws. There are five toes on the fore feet and four on the hind feet. Many breeds are kept, and illustrations of these can be obtained from a paper such as the *Dog World*, which is published weekly.

The Cat

Though often kept in the house as a pet, the cat does not give so much real affection as a dog, or at any rate it does not show it so readily Young cats are particularly playful in their habits and graceful in their movements. The cat is usually gentle, and makes a good pet for a child It is also useful in that it destroys rats and mice, which are pests in some houses.

The cat is a meat eater and a hunter. Wild cats are particularly savage, and the beasts of prey are mostly members of the cat family. The teeth are well developed for the purpose of tearing meat and killing smaller forms of life. The claws can be drawn back into sheaths within the paws, and are particularly sharp and curved. The cat does not chew its food. The tongue is rough and file-like· the very last bit of flesh can be removed from a bone with the tongue.

The long years in which cats have lived with man have somewhat altered the habits inherited from savage ancestors Yet cats still love to steal away for the adventure of hunting in the fields, hedges, or in the haunts of mice and rats

WILD ANIMALS OF THE COUNTRYSIDE

The Rabbit

The rabbit is known to both town and country children. It is an animal which in its natural state lives in burrows in the ground, and feeds entirely on vegetable food Food is obtained not only from herbage but also from bark gnawed from trees For this reason the rabbit does considerable damage The front teeth are chisel shaped In the wild state the rabbit feeds at night. The grey-brown colour of its fur is especially suitable to act as a protection against

observation. On alarm, the feeding rabbits remain perfectly still. Then one or more raise their tails and the warning patch of white is a signal for a general rush to the burrows. Where the country is quiet, and foes of the rabbit are few or none, the rabbit will often feed in the day time.

The rabbit for many years has been kept as a pet. In addition, rabbit farms are run in order to obtain the fur. Breeding of rabbits commercially has led to many different varieties with various markings on the fur The flesh is

FIG. 70
A Hare
The grass nest of the hare is called a form.

also sold for food. Wild rabbits are trapped and shot for their flesh. (The hare is larger than the rabbit, is more swift of foot, and does not live in burrows. The shape of the body is somewhat different too.)

The Fox

This well-known wild animal is hunted by packs of dogs in the British Isles. It is a member of the dog family but has a differently shaped head from the domestic dog's, and its eye pupils are elliptical, not round. The fox has a long, thin body with a reddish brown coat; the fur on the stomach is white. The long and bushy tail is known as the *brush*. The fox lives in a burrow. This the animal may construct for itself or it may use that of rabbits or badgers Baby foxes are usually born in April, and there are usually four or five in a litter. The food of the fox consists of small animals, birds, insects, and fruit. Prowling in the night, the fox often kills large numbers of poultry. This makes him an enemy of man. Were it not for the protection afforded to the fox by the hunting community it is probable that it would have become extinct. Farmers would not tolerate its raids on the poultry farm.

The Stoat and the Weasel

The stoat is a flesh-eating mammal of the weasel tribe. It is about 10 in. in length, the female being shorter than the male. In summer the coat is reddish brown above and white below, the ear being tipped with white and the tail with black. In winter the coat may be white except the black tail tip The name *ermine* is applied to the animal when white. The change in colour occurs only in colder climates, so that whilst stoats in England rarely become pure white those of northern Scotland and Scandinavia do No stoats are found in Ireland. Stoats hunt and feed at night on rats, mice, and similar creatures. Rabbits and hares are also attacked by them. The white fur is valuable.

The weasel is not quite so large as the stoat, being rarely more than 8 in. long. In colour and habits it is very similar to the stoat

The weasel hunts with great ferocity, and is particularly fond of poultry and eggs The weasel often lives to four years of age, but a stoat rarely lives more than two years.

The Badger

The badger is a much larger animal than either the stoat or weasel, being over 2 ft. long when full grown. It is grey, but striped with black and white down the head. The badger lives in holes in the ground, and is only to be found in the more secluded parts of the country. Hunting by night, the badger feeds partly on roots and insects, although it is really a flesh-eating type of animal. It is quiet and inoffensive in its habits unless attacked, when it is fierce and stubborn. A sport once common in Great Britain was that of badger baiting. small dogs were encouraged to attack a badger. This sport is now prohibited. Badger hair is used for brush making. In China the flesh is considered a delicacy.

TYPICAL ANIMALS OF OTHER COUNTRIES

There are numberless animals which might be described, and the PRACTICAL JUNIOR TEACHER charts will give an idea of the comparative sizes of some of them.

Native countries of some well-known Animals—

Chimpanzee, Gorilla, Monkeys	Equatorial West and Central Africa
Gibbon	Malay
Tiger	India, Malacca
Leopard	Africa, S. Asia
Puma	America
Jaguar	Central and South America
Lion	South and Central Africa
Brown Bear	Northern Latitudes
Grizzly Bear	Canada
Beaver	Canada
Buffalo	Canada
Yak	Tibet
Antelope	India
African Rhinoceros	Upper Nile
Indian "	India, Malay
Dromedary	Asia and Africa
Camel	Central Africa
Zebra	East and South Africa
Giraffe	East and South Africa
Kangaroo	Australia
Hippopotamus	Africa
Crocodile	Africa
Alligator	America

Carnivorous Types

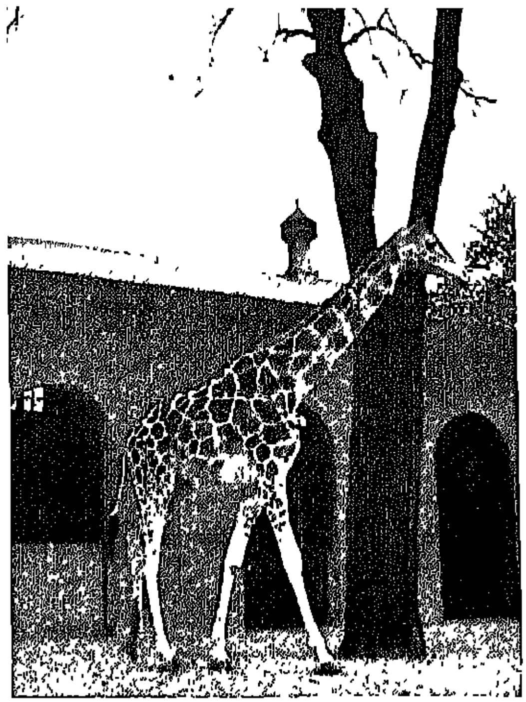
The lion that feeds on grass-eating animals, the tiger, larger and more cruel, that creeps through the long bamboo grass, and the leopard, whose coat resembles the dappled shadows made by the trees, might be taken as types of meat eaters. It may be mentioned that the male lion in the natural state does not possess the bushy mane so characteristic of him in captivity. Some types never develop the mane at all, but in those that do it is constantly being torn off by undergrowth.

Herbivorous Animals

Throughout the world man has sought these as food through long ages. The Red Indian hunted the bison. Deer, antelopes, and buffaloes have been hunted in other parts of the world.

Interesting Wild Animals

The elephant is found in Africa and Asia. The Asiatic or Indian elephant has smaller ears but a much larger head than the African type. The African elephant has only three nails on the hind feet, whilst the Indian has four. The trunk, which is really an elongated nose, has two finger-like ends in the African elephant, and but one in the Indian. The Indian elephant is often blotched with white. The African elephant develops large tusks, and is valued for the ivory these yield. The Indian elephant is used as a draught animal. Elephants are vegetarians.



Kodak Snapshot

FIG. 71

A Giraffe in the Zoological Gardens, London

The native name is "Zurnapa," an Arabic word meaning "the beautiful"

The giraffe always amuses children by its long neck and peculiar gait. The body is small, the hind part being lower than the front. Two short horns are found in the head. The tongue is long. Food, which is vegetable, is obtained from trees and bushes. The giraffe may be as much as 18 ft. high and can only touch the

ground with its head by stretching the legs wide apart.

The kangaroo is interesting as being a pouched mammal. The animal is found as a native only in Australia and New Guinea. Many species are known, some as small as rabbits and the largest 5 ft. in length of body with a four-foot tail behind The kangaroo is a vegetable feeder, eating at night. The young are kept for some time after birth in a pouch Even when able to feed on grass the tiny kangaroo will bound back to the pouch on any alarm of danger.

KEEPING PETS

There is considerable value in keeping pets. Children learn to treat living things with respect and kindness. It will be found that these traits are not necessarily inherent in children. Young animals do not always find their most considerate friends amongst untutored children. On the other hand, the patience and tolerance displayed by animals for the tugs and twists inflicted upon them by tiny children must be admired.

In the army and in the backwoods the soldier or wanderer gives first consideration to his animal. The physical needs of the horse, mule, or camel often come before those of the man. Children learn habits of regularity and order when they have pets to consider

There are also lessons of biology and the laws of life which can be observed and assimilated when pets are kept. Young Farmers' Clubs encourage boys and girls to care for and tend something that lives and grows. The Junior School Nature Scheme might well have some place in it for the encouragement of the keeping of pets by boys and girls.

Many difficulties have to be overcome. Parents are not always anxious to allow their children to keep animals. Children, too, whilst keen for a time, sometimes seem to lose zest for their pets almost as quickly as they took up the task of caring for them. Then conditions at school are not always suitable for communal pet keeping. In country schools it is sometimes possible to have ranges of rabbits' hutches, pens of poultry, or a small aviary. In the town school this is not possible.

What, then, can be suggested to overcome some of these difficulties? In the first place it is evident that some children in the school will already keep pets—cats, dogs, canaries, rabbits, and perhaps tame mice. Arrange a pet show, either separately or in conjunction with the school flower show Invite the parents to the show, charge them a small entrance fee if you like, and offer prizes. It is an illuminating experience. On one occasion some twenty dogs were brought to school to be judged. No judge ever had a more difficult task. The dogs were nondescript in breed, but had been very carefully groomed. It was quite a social event judging those dogs in the school playground, and what a crowd formed the ring Similarly the cats and kittens, rabbits and canaries, guinea pigs and mice were a mixed collection Those who had never believed in keeping pets before or who doubted the wisdom of linking the school with pet keeping would have been converted.

After the show has stimulated interest the next thing to do is to arrange for some after-school talks on pet-keeping by some one who might be called an expert. The Inspector of the Royal Society for the Prevention of Cruelty to Animals is always a friend who can be relied upon to give assistance in this way. A school pet show may lead to the discovery of other friends who can be induced to come and talk to the children.

The teacher may talk about the various kinds of pets and give some little instruction that will be helpful to the children.

Dogs

Dogs serve various uses The farmer and hunter have their dogs to assist in their work. The dog which the child will keep will be a pet, but may also be a watch dog. The large dogs are not suitable for small houses. Amongst those that can be recommended are terriers—fox, Irish, black and tan, Scotch, Skye, and Yorkshire—pomeranians, chows, and spaniels.

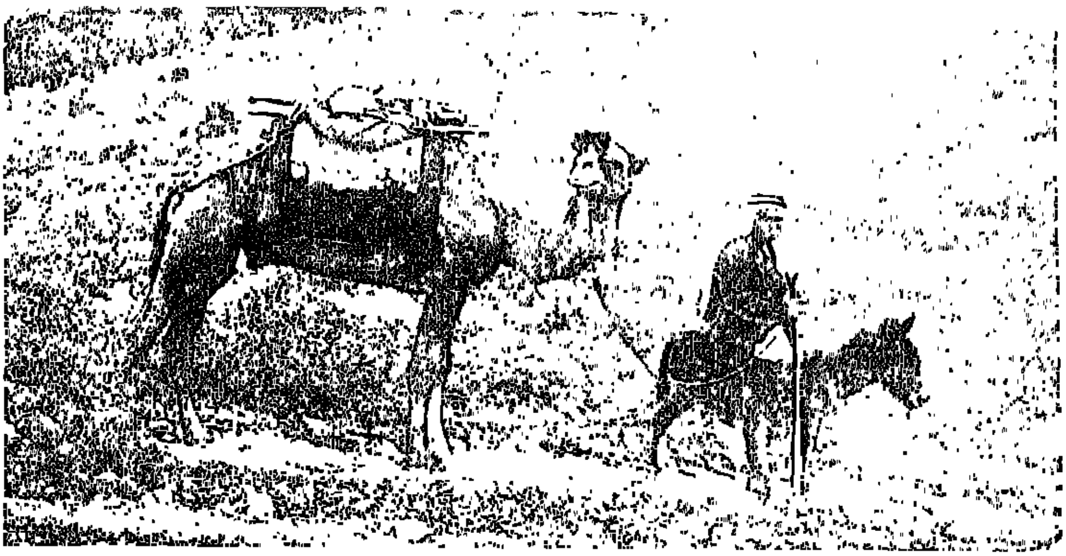
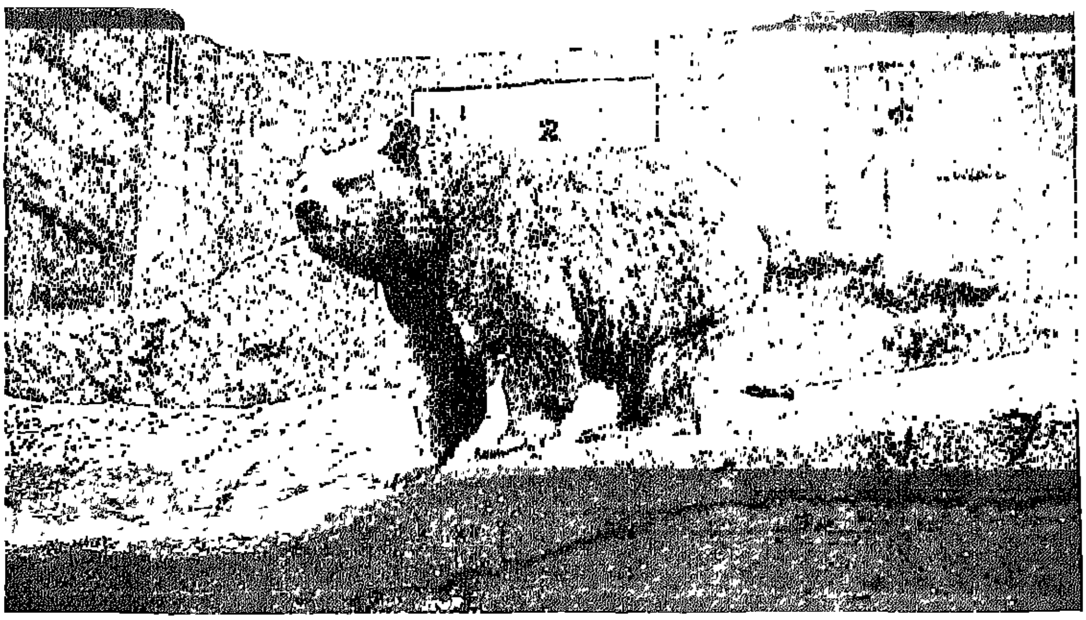


FIG. 72

A Camel near Haifa

One-humped camel used in Arabia and North Africa for transport purposes. One species is called a "dromedary," a word which really means a camel used for riding. Whilst this type are fleet of foot, others are merely draught animals, carrying from 6 cwt. to almost half a ton



Kodak Snapshot

FIG. 73

A Brown Bear at the Zoological Gardens, London

The Brown Bear, found in Northern Europe, is very similar to the Grizzly Bear of North America, though the snout of the Brown Bear is stronger, the ears larger and more upstanding, and the eyes farther apart than those of the Grizzly Bear

A puppy is interesting to a child, and there is pleasure in seeing the wee dog grow up. Patience is required to teach puppies good habits, and distemper often takes toll of baby dogs; steam from hot water containing eucalyptus oil gives relief to the catarrh which this involves

Cleanliness is essential Bathing is sometimes necessary The coat should be brushed daily. A dog needs exercise and regular walks should be taken with the dog. Meals should also be regular. Too much meat is harmful Small bones should not be given as they splinter and may cause internal injury. Small dogs may sleep in a basket. Where a kennel is provided it should be dry, warm, and sheltered. Dogs like company, so have them indoors as much as possible.

Cats

Generally cats require no special sleeping place, and as they are most assiduous in their own care of their coats require no attention in this way, though Persian cats sometimes need to have some of the old coat removed when new hair is growing. Cats should be allowed to go out sometimes as they require exercise as well as do dogs. Fish and meat should be given sparingly Bread and milk, gravy and vegetables make quite good food. A little cooked meat can be given.

Most of the cats kept are mongrels, but there are many beautiful pure breeds. The long-haired chinchilla and the long-haired tabby are very showy. The tortoise-shell cat with short hair is well known.

Rabbits

Rabbits should be kept only where there is plenty of room for the hutch—it can be at some distance from the house in a sheltered spot. The hutch should be placed where it will catch the sunshine at some time of the day. It must be built so that the floor slopes slightly to give drainage, and should be divided into a sleeping compartment (with no light), and a run covered with fine wire. The sleeping place should be supplied with dry straw or bracken—*not* hay. A spring clip should be arranged on the wire into which hay or green stuff can be clipped. The animals can feed from it without soiling the food. Great fun can be had in summer by constructing a movable run in which the rabbits can be placed on a lawn. They will enjoy feeding from the grass, and the run can easily be moved to a new place when all the tender leaves have been eaten from one patch

The first meal of the day should be of oats and bran, with green stuff to follow. The evening meal may be similar Green stuff and hay should be kept in the clip and renewed frequently.

Cleanliness must be observed, and the hutches should be cleaned out at least once a day.

Angoras are pretty rabbits with long white fur. They require considerable attention to keep their fur in good condition and unmatted.

Chinchillas are hardy rabbits and good pets.

Other varieties are Belgian Hares, Blue Beverans, and Dutch.

Some Other Pets

1. *Mice.* These require a plentiful space and considerable attention with regard to cleanliness in their quarters, otherwise they become objectionable. Sawdust should be placed on the floors of the cages, and this should be changed very frequently. The mice should be fed on vegetable food—oats, wheat, and bird's seed are the best. Water should be provided.

2. *Guinea Pigs* can be kept very much in the same way as rabbits, but the hutches should be placed in a shed during winter as these little animals are more delicate and cannot bear very much cold.

3. *Cage birds* are often kept as pets. There are arguments for and against the practice. Where birds are kept in cages, the cages should have only one wired side, the front The cage should be kept out of full sunlight and draughts. Perfect cleanliness should be ensured, a plentiful supply of water provided, and suitable food given. Canaries like seeds of millet, canary seed, rape, groats, and linseed. A variety from day to day should be given and not variety at one meal. Titbits in the way of boiled egg, meal-worms, and small caterpillars can be given.

Mule birds are those bred from a pair of birds

one of which is a canary. They are generally more hardy than pure-bred canaries. Among the possible crossings are: goldfinch-canary, chaffinch-canary, and linnet-canary.

Aquarium Life

Some study of the life of creatures and plants which live in water can be made where an aquarium is provided for the purpose. An aquarium is a glass vessel or one with glass sides in which water creatures and plants can be observed. If the water is fresh then the aquarium is known as a fresh-water aquarium, if it contains sea water then it is known as a marine aquarium.

Buying an Aquarium

The simplest form of aquarium is, of course, an ordinary glass bowl or rectangular dish, which can be purchased for less than 10s. Where funds will allow it is better to purchase a proper rectangular tank. A built-up aquarium 18 in. long, 12 in wide, and 12 in. deep can be purchased for about 50s. A large one 4 ft. long, 15 in. wide, and 15 in. deep costs about £9. A cheaper kind can be made by a skilful amateur. On a stout base board, angle plates are fixed. These plates rise vertically from each corner. A slab of slate is placed on the base board and sheets of glass are fixed between the angle plates. The glass sheets and slate are made waterproof at the joints with special waterproof putty which can be purchased for the purpose. There is good fun in keeping an aquarium, even if it is made in a large glass jam-jar

Preparing the Aquarium

Having secured the aquarium the next business is to prepare it for use. The bottom must be covered with sand. Any one who has stirred a spoonful of clay into a glass of water will realize that the fine particles take hours to settle, if any clay gets in the tank the slightest movement of fish or plant will make the water murky for a long time, so it is necessary to wash with many changes of water the river sand which has been obtained. Similarly any rocks, stones, pebbles, shells, or ornaments which are to be placed in the water must be scrubbed and washed in several changes of fresh water.

Water. For a fresh-water aquarium water may be obtained from a pond. See that the supply is clear and free from clay. Where no pond water is available place rain-water in the tank Tap water is not to be recommended.

Aquatic Plants. A knowledge of Nature study shows that there is a balance of plant and animal life within a pond. The plants supply the oxygen, which is slightly soluble in water, for the fish and other creatures to use in order to maintain life. Thus it is necessary next to obtain some

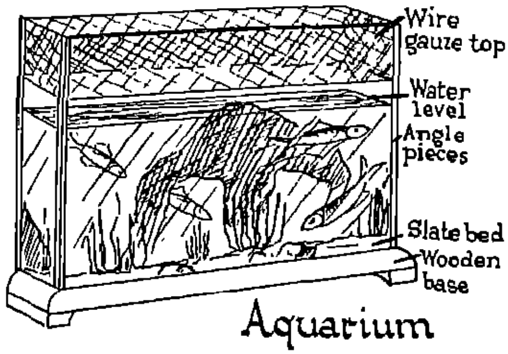


FIG. 74

plants for the aquarium. Pond plants are easily obtained from ponds or the margins of rivers. These should be removed with roots and washed before placing them in the aquarium. It is possible to purchase pond plants from naturalists or in a large town an inquiry to a store may be successful in securing some plants. The Canadian pond weed is suitable, as it grows quickly and needs no soil for the roots Other kinds are willow moss, water-mint, and water crowfoot. Floating plants can also be used and the common duckweed is easily obtained. Small pebbles should be tied with silk to the roots of rooting plants, and these should be put under the sand with the pebbles placed on top The plants should be left for two or three weeks to allow them to become established.

Inhabitants of the Aquarium

In towns the easiest way to begin is to secure a number of goldfish—according to the size of

the tank—and to place them in the aquarium. Very interesting observations on the method of swimming—rising, falling, turning, propulsion, etc.—can be made. The moving fish will be a never ending source of interest to the Juniors. Do not place the tank in direct sunshine for too long a period. Those who have seen tanks of fish in some fishmongers' shops will realize that in addition to goldfish there are other suitable fish—a small perch or roach, two or three gudgeons, a chub or a dace are all possible choices. Some of them will thrive together

Other creatures may be included, too, though a sheet of muslin, perforated zinc, or glass is necessary to keep some of them from straying. Naturalists can often supply suitable examples of pond life. It must be remembered that some creatures prey on others. The great water beetle is harmless to other life, the great diving beetle is a foe to fish, snails, and other life. The diving-bell spider is interesting. At certain times of the year the changes in the larva of the dragon-fly may be observed, and the way the spawn of frogs or toads change until the complete creature is evolved is worth studying.

Shell fish should also be included. These creatures will keep down the green slime which would otherwise form on the glass. They can be obtained from pond edges, canal sides, and sometimes from brooks. The duck mussel, and the fresh-water cockle and mussel can be obtained. Experience will teach how to maintain a balance of life, and observation will show what creatures are destructive.

Food should be supplied twice a day, but only in small quantities. Care should be taken to remove superfluous food as it will cause the water to become distasteful. Ant's cocoons, vermicelli, fish meal, and various kinds of worms are among the kinds of food which can be given Raw meat minced up can serve as a substitute when none of these can be obtained. Food for the creatures of the aquarium can be easily purchased at Naturalist's shops.

Water should rarely be changed. If the proper proportion of plant life is present then the water will remain pure and wholesome. Should the fish be seen continually coming to the surface of the water it is probable that there is not enough air present and the water wants aerating. This can be done by forcing air in with a fire hose hose or by letting water drip in so that air is carried in with the water. Where the water is completely changed it must be allowed to stand in a bucket or tank for some time so that it becomes at the same temperature as the water already in the tank. Goldfish are especially liable to die if great differences of temperature are experienced. Water drawn from a tap is considerably colder than water which has remained for a long time in a bowl or aquarium, and yet people often change the water by merely adding tap water!

A Marine Aquarium

This should be filled with real sea water; ordinary water may be added from time to time to maintain the water level. Seaweed and many of the beautiful sea plants may be obtained during a visit to the seaside. Sea anemones, shrimps, and shell fish also can be collected. Of course, they must be carried home in jars of sea water. It is recommended, however, that only schools actually near or on the sea coast should keep a salt-water aquarium.

Pond Life

Every pond, stream, and brook is full of living creatures ranging in size from organisms that can be seen only under high-powered microscopes to large shell-fish and beetles. Temporary pools in a field, stagnating water in ditches, and even vases in which cut flowers are placed soon become alive with myriads of creatures, some very primitive in their structure but all illustrating the wonders of life processes.

Though the teacher in the Junior School may be interested in studying these, it is not practical to give detailed attention to pond life in the Junior School. Yet it is worth telling the children something of the creatures of the pond, and, where possible, showing them such living things.

Here it is only proposed to comment briefly on one or two interesting features

The life history of a frog can be partly studied in school by obtaining some frog's spawn and

watching its development. The changes which occur in the creature may be summarized as follows—

1. In late spring the female lays her eggs in large masses; each egg is enclosed in an encircling mass of gelatine. The mass of eggs is known as *spawn*. It is quite easy to secure some of this in April from almost any pond

2. Whilst in this spherical state each egg which is fertile begins to grow The jelly-like covering prevents the eggs from overcrowding each other. The heat of the sun is also trapped by this arrangement.

3. In about a fortnight (the length of time depending on temperature and other conditions) a *tadpole* hatches from each egg

4. The baby tadpole has no mouth at birth, and lives on the food stored within it (*cf.* broad-bean and chicken) Small gills outside the main body are used for breathing, oxygen dissolved in the water being absorbed and carbon dioxide being given up. Suckers are present on each side of the head so that the baby tadpole can cling to plants and other supports

5. A mouth develops, internal gills appear, and the creature begins to feed on vegetation.

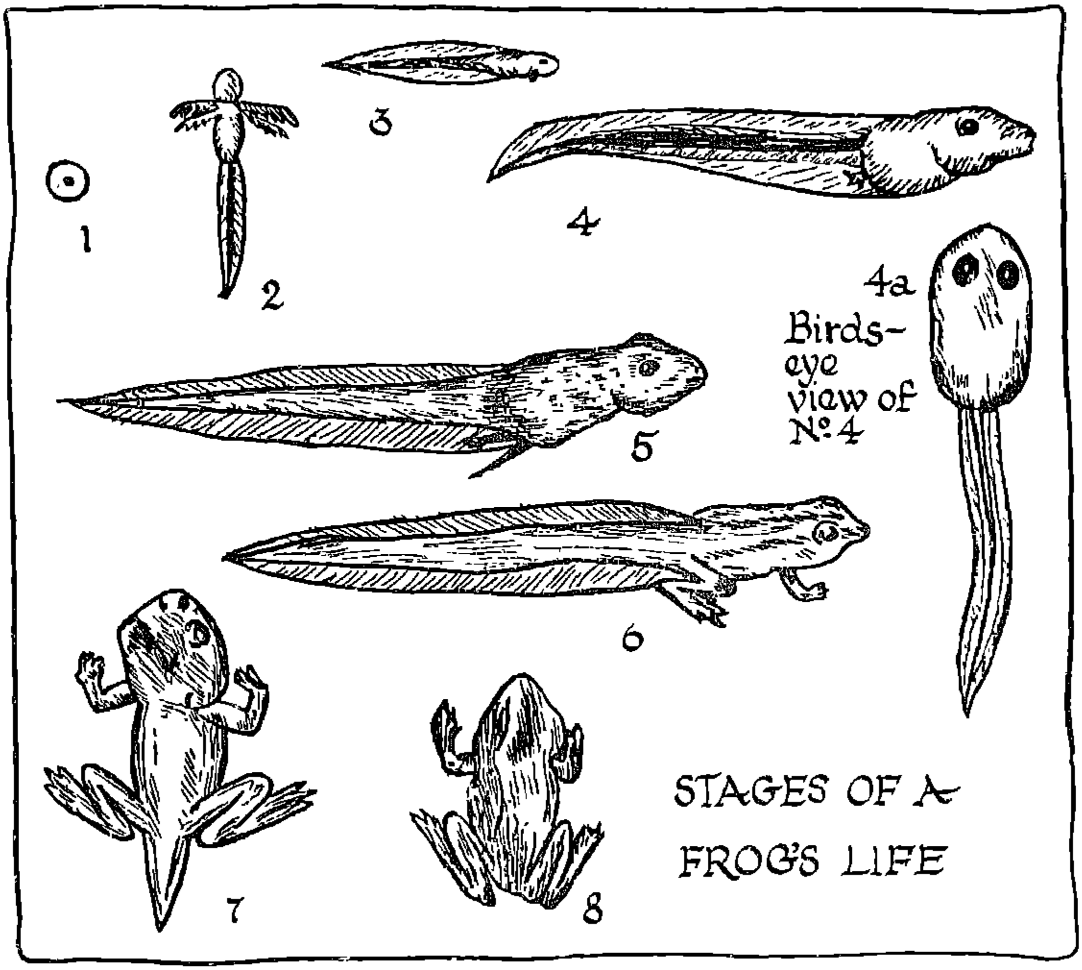


FIG 75

6. Hind legs develop.

7. Front legs begin to form and the lungs develop.

8. The lungs are used as well as the gills The tadpole frequently comes to the surface of the water to breathe.

9. The gills diminish and finally close, the tail shrivels up and the tadpole has become a frog.

Toads' eggs are laid in long strings and not in masses. Both frogs and toads feed on slugs and insects. The toad does not seek the water as much as the frog, going there practically only at breeding time. Gardeners encourage toads because they destroy many insect pests Frogs do a similar service, but rarely stay long in one place.

Beetles can often be seen swimming on the surface of the water or under the water.

The largest British beetle is *Dytiscus*. This beetle feeds on tadpoles, etc., and is carnivorous. The male can be differentiated from the female because he has on his front legs two pads which give out a gummy substance. The beetle comes to the surface to breathe. Air is drawn in at the back of the abdomen and entrapped under the wings. The eggs are laid on stems of weeds, a larva develops with a brown segmented body, six legs, and special air tubes on the end of the abdomen.

Whirligig beetles can sometimes be seen. They are oval in shape, and can be seen whirling about on the top of the water. When frightened they dive below the surface and hide under the bottom of the pond.

The water boatman is well known. Its body is very similar to that of a boat. The creature lies on its back. One pair of its legs are used always as oars, the other being mainly used for holding its prey or seizing on some support. When frightened the water boatman dives beneath the surface, but has a difficulty in remaining long under water owing to the lightness of its body.

Water spiders are found in ponds. One, the wolf spider, hunts its prey instead of making a web to entrap them The true water spider has an underwater home The web, which is like an inverted thimble, is full of air, with an entrance at the bottom. The spider carries air down to the house by entrapping it between hair-like growths on its body.

The mosquito is definitely a foe to man because it has the power of carrying germs of disease from one person to another. The egg is deposited in water and the larva and pupa stage are spent in water. Thus in all ponds the larva of the mosquito and gnat can be found. A film of oil on water prevents the larvae from obtaining air, and so they die. This method of eradicating the mosquito has been successfully tried.

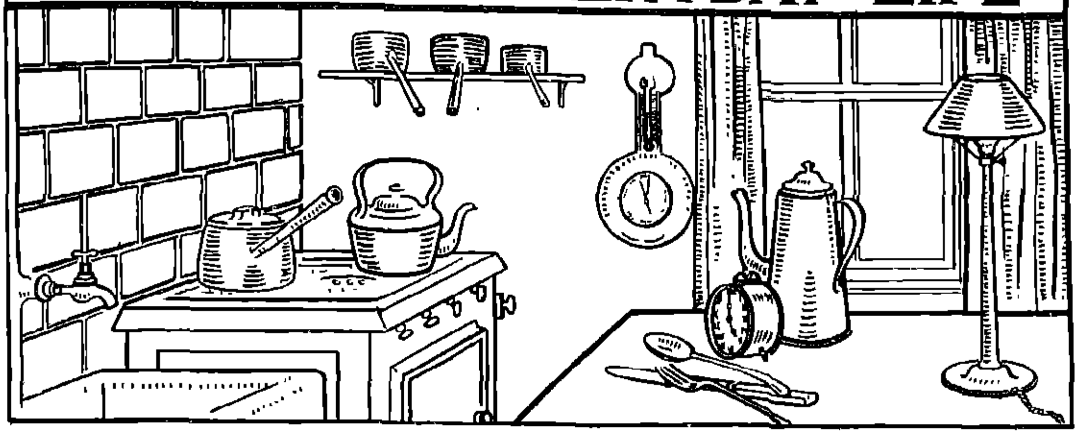
The dragon-fly can often be seen flying over a pond in summer. Its beautiful colouring is very attractive. The body is very long, there are four wings, and the eyes are large and prominent. The flight is strong, swift, and agile Insects such as flies are chased by the adult dragon-fly. The larva spends its time in the water It has a special mask or appendage of the jaw, which it can thrust forward to sieze its prey. There is practically no pupa stage. After about a year in the water the nymph crawls up the stem of a water plant. In a short time the skin cracks and a perfect dragon-fly is seen to emerge

The caddis fly is like a light and graceful moth. The eggs are laid on a pond surface or just beneath the surface, and are surrounded with jelly The larval and pupal stages are passed in the water. The larva after a few days begins to construct a home for itself. This home is tube-like, and is built of grains of sand, leaves, sticks, etc. The end of the tube is closed when the larva is about to turn into a pupa. At the end of the pupa stage the creature emerges from the tube, moves about in the water for some time, and then rises to the surface whence it rises as the perfect and moth-like insect.

Many other creatures can be observed: the May fly, various snails and worms, frogs, newts, and fishes of various kinds from the small stickleback and minnow to the large pike

Also the plant life of a pond is interesting.

THE SCIENCE OF EVERYDAY LIFE



"Science: The choice of topics should be closely related to the children's interests and their treatment should aim at providing an answer to their inquiries which will satisfy them for the moment, without destroying their wonder, or quenching their natural curiosity. 'How it works' is a good practical guide for the teacher in all this early work."—THE REPORT ON THE PRIMARY SCHOOL, 1931.

BOYS and girls often wonder how many of the things they see every day work In the upper classes of the Junior School, a very interesting course of lessons can be given explaining some of these mysteries. This section will give a series of notes which may be utilized by the teacher in arranging a Junior science course. In a few cases it will not be possible to give a complete answer to the questions asked. For example, in describing how a flash-lamp works, or why an electric bell rings, a full discussion of electrical and chemical theory cannot be given. At the same time, explanations will be suggested which will give no false scientific ideas This is very important. Teachers of science in the Secondary Schools often find difficulties arise in their work because wrong impressions have been conveyed in Junior classes. This emphasizes the importance of the work of the Junior School teacher. It is found in English, history, and geography that the facts learnt in the Junior School are those which most readily abide. Similarly, in science, conceptions given whilst the children are young are most easily remembered and reproduced in later years. It is, therefore, vitally important that the work, however limited it may in some schools have to be in scope, should be built on the right principles.

WEATHER AND KINDRED RECORDING APPARATUS

The Weather-Cock or -Vane

This is used to show clearly and quickly the way the wind is blowing. The first weather-cock is said to be the brazen Triton on the Tower of Winds in Athens, erected about 100 B.C. The vane in its simplest form consists of: (1) a thin plate of wood or metal fastened to a vertical rod in such a way that *more* than half the plate is on one side of the rod; (2) a socket into which the rod fits, (3) four arms at right-angles, marked with the four chief cardinal points, fastened below the socket. When the wind blows, the plate will turn so that it suffers the least pressure from the wind. This can be illustrated by fixing up a simple vane and blowing on it from various directions The state of the weather which may be expected can be roughly judged from the direction from which the wind blows. Thus, in England a south-west wind

generally means that rain may be expected. The little rhyme beginning—

The north wind doth blow
And we shall have snow. . . . .

indicates the same idea.

The Rain-Gauge

This is an instrument used to find the amount of rain which has fallen. Rainfall is always

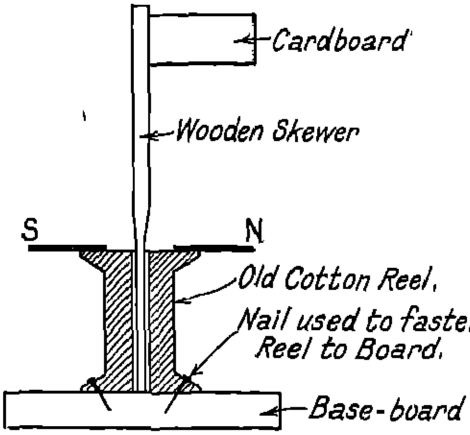


FIG. 1
How to Make a Weather-Cock for Demonstration Purposes

quoted in inches or centimetres. When it is said that an inch of rain has fallen, it means that if the land were perfectly level and water-tight the rain would cause water to the depth of *one* inch to cover the land. This gives an indication of the most simple rain-gauge. A glass jar or beaker with perfectly perpendicular sides, placed on a flat surface out of doors, would "catch" any rain that fell over it. Then, if a scale were pasted to the sides of the glass, the amount of rainfall could be read off. This kind of rain-gauge is open to several objections.

1. It would be difficult to read very small falls of rain.

2. Rain which was caught at one period might be lost by evaporation later on in the day.

3. Rain might be lost by splashing, etc.

In order to overcome these objections, a modern rain-gauge consists of four parts—

1. *The container*, which is a cylindrical tin.

2. *The lid*, which exactly fits over the cylinder. The top is made into a *funnel* which goes down into the cylinder The neck is narrow and the end turned up.

3. *The holder*, which is a small tin placed inside the cylinder. The neck of the funnel is inserted in this holder.

4. *The Measurer.* This is a tall glass cylinder very much smaller in diameter than the container. Scientists graduate the glass cylinder so that very slight falls of rain can be measured. They calculate what volume of water would fill the container to a depth of one inch. This volume is placed in the glass cylinder. It will occupy a depth of perhaps 4 in. or 5 in. A mark

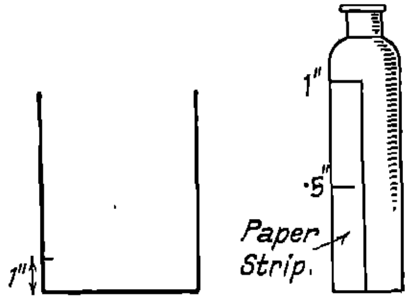


FIG. 2
A Simple Rain-Gauge

is made at this point, and the glass cylinder can then be graduated into tenths and hundredths. To use the apparatus, the water from the inner tin is poured into the glass measurer and the rainfall is read off on the scale.

It is possible to graduate a glass for class use. Obtain a circular tin. Measure one inch from the bottom, inside, and make a mark on the side. Fill up to this mark with water. Pour the water into a medicine bottle. Mark on a strip of paper placed on the side the height reached by the water, and divide this measurement into ten equal parts. Of course, this simple rain-gauge cannot be expected to be very accurate.

The Barometer

This instrument will doubtless have puzzled many children. The dial on which a pointer indicates fine, unsettled, or stormy weather, and

shows when rain may be expected, is certainly something of a mystery.

The first point to teach is that the atmosphere has weight and can exert pressure in all directions. This can be taught—

1. By speaking of the effect of high winds and the destruction that is sometimes caused.

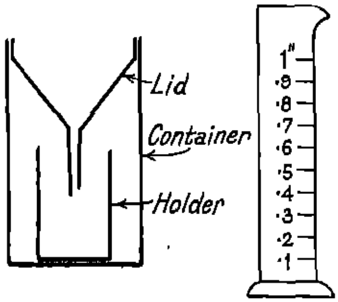


FIG 3
Parts of a Rain-Gauge

2. By the simple experiment of filling a tumbler exactly full of water, placing a card on top and inverting The hand should keep the card against the rim until the glass is inverted. Then it can be removed. What prevents the water from falling out? It must be the upward pressure of the air

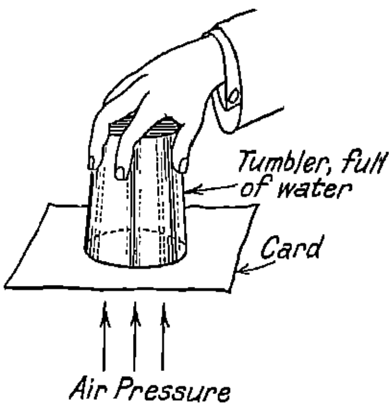


FIG 4
Experiment Demonstrating Air Pressure

Air Pressure

Now speak of the effect of the pressure of a number of sacks stacked one on top of each other. The lowest sack would be compressed most. Pressure would lessen as the top was approached. This is analogous to air pressure, which is greatest at sea-level. Now procure a long tube. Fill it with water. Place the thumb over the top and invert, placing the end in a bowl of water. Notice that the water column is not lessened. Here the air pressure on the surface of the water in the bowl is transmitted to the water column and supports it. If possible, now secure a tube closed at one end and about a yard long Fill with mercury and invert as before in a bowl of mercury. The column of mercury in the tube will fall until it is about 30 in. high. From this fact deduce the fact that air pressure

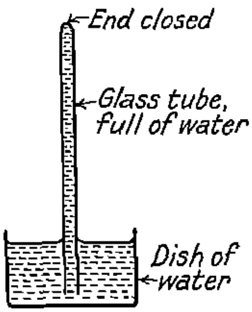


FIG. 5
Transmission of Air Pressure

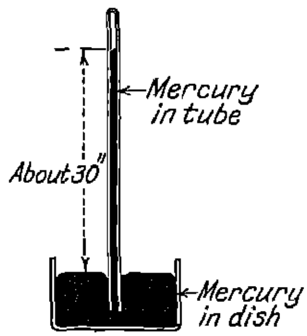


FIG. 6
A Simple Barometer

can only support a column of mercury of this height, mercury being heavier than air. This will give some idea of the pressure of the air. Now discuss the point as to what would happen if the inverted tube of mercury were carried up a mountain. Most children will see that the column of mercury would become shorter, because the pressure of the air is less.

The next stage is rather more difficult. No experiment can be performed simply to illustrate the fact, but it must be explained that *water vapour* is less heavy than air. So, if there is a great deal of water vapour in the atmosphere then the pressure of the atmosphere will be less, and the column of mercury which can be supported will be smaller. Now, when a great deal of water vapour is in the air, there is more likelihood of rain. The principle on which the barometer works is to be found in this fact.

There are several kinds of barometer—

1. The simple inverted tube with scale at top end. (See Fig. 7.)

2. The siphon barometer with special arrangement for moving the pointer. (See Fig. 8.)

3. The aneroid barometer. This works on an entirely different principle. It consists of a cylindrical metal box from which some of the air has been pumped out. The top of the box is made of thin corrugated metal which yields to any slight difference of pressure placed upon it. When the pressure increases, the top is pressed inward; when it is lessened, it springs outward. Special levers are attached through a spring to this lid and a pointer moves on a scale whenever the box lid moves. The dial is marked by experiment.

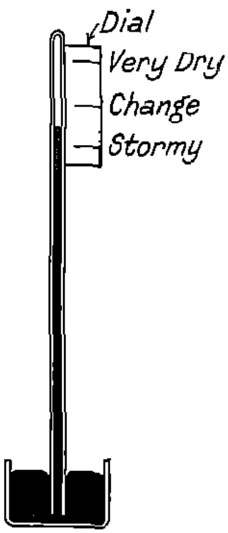


FIG. 7
Simple Barometer and Scale

It may be well for the teacher to point out that a barometer could be made filled with water instead of mercury, but owing to the fact that water is $13\frac{1}{2}$ times lighter than mercury, the air could uphold a column of water $13\frac{1}{2}$ times as high as that of mercury. Thus, a tube about 35 ft. long would be required.

Pressure of the air on the human body is about 15 lb. to the square inch. It may be mentioned that airmen and mountain climbers, who reach high altitudes, experience discomfort and often bleed from the nose and ears.

Several articles in common use depend on air pressure, and will be described later.

The Thermometer

This instrument for recording temperatures depends upon the fact that when most substances are heated they expand and take up more room. That solids expand on heating can be shown in several ways. One simple method is to cut out a metal gauge into which a nail will just fit when cold. When heated, the nail will not fit in the gauge, but will do so again on cooling. The teacher might refer to the spaces left between railway lines. To show expansion of liquids the following experiment is recommended. Obtain a flask or bottle with a cork to fit the neck Bore a hole in the cork and fit a tube Fill the flask with water coloured with red ink, insert the cork and tube, and

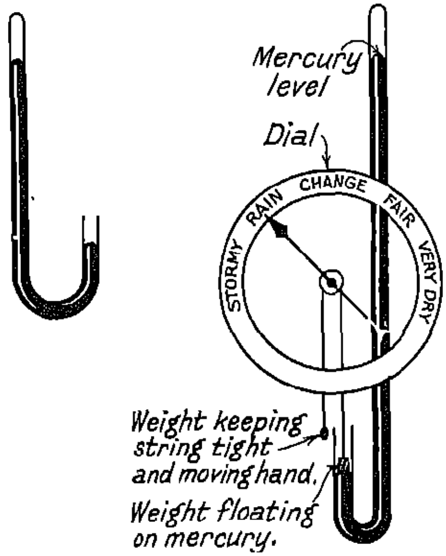


FIG. 8
Siphon Barometer

arrange so that the water comes an inch or two up the stem Obtain a bowl of hot water. Stand the flask in it. Notice that—

1. The water in the tube begins to sink.

2. Shortly the water column will begin to rise rapidly.

The initial fall was due to the fact that the flask expanded and could hold more water. Very soon the larger bulk of water began to expand and so rose in the tube.

The thermometer consists of a glass tube with a small bowl of liquid attached. Special precautions are taken, but these need not be dealt with in the Junior School. The liquids generally used are mercury and alcohol. The alcohol is coloured with a dye so that it may more easily be seen. Alcohol is used for measuring *low*

temperatures as it freezes only at $-130°$ C. Mercury is used for higher temperatures. In order that comparisons can be made easily, *scales* are marked on thermometers. First the

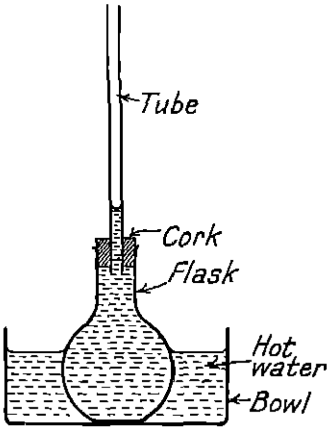


FIG. 9
An Expansion Experiment

two fixed points are found: these are (1) the position occupied by the liquid when the thermometer is placed in melting ice—known as *Freezing Point*; (2) the position occupied when

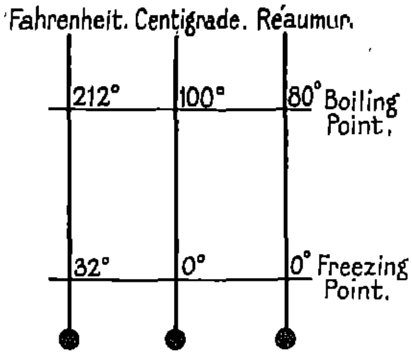


FIG 10
Thermometer Scales

the thermometer is suspended over freely boiling water—known as *Boiling Point* If the scale to be marked on the thermometer is to be the Fahrenheit one, then Boiling Point is marked 212° and Freezing Point 32°, and 180 equal divisions are marked off in between In the Centigrade Scale, Boiling Point is 100°, Freezing Point is 0°. Children may be shown thermometers marked in both scales and also in that of the Réaumur scale (Boiling Point, 80°; Freezing Point, 0°).

The Clinical Thermometer, with which the temperature of children is taken, has a very narrow place in the tube containing the mercury. The liquid is forced past this, but will not pass back without violent shaking of the instrument. Thus, the level to which this mercury rose can be read after the thermometer has been taken from the mouth.

Valuable training in accurate observation is given if children are allowed to take daily readings of a thermometer both within and out of doors.

Magnets and the Mariner's Compass

Many children will possess a little pocket compass. A lesson on the magnet will not, therefore,

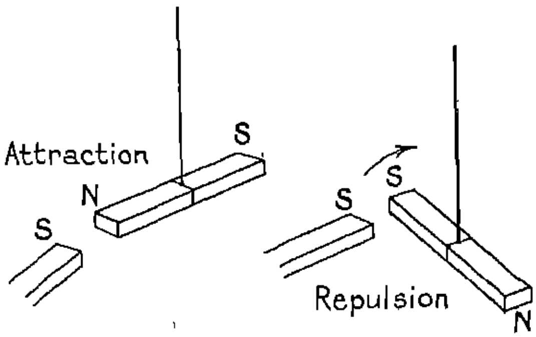


FIG 11
How One Magnet Affects Another

be out of place. For this the teacher should obtain two bar magnets and a mariner's compass.

Hang up one bar magnet and mark one end with a chalk mark to differentiate it clearly from the other. Notice that one end always points toward the *North*. Here it may be shown that it does not point to the exact *geographical* north; this fact will probably have been brought out in the geography lesson. Mark the end which points in a northern direction with an *N*. Hang up the other magnet and find the end of this which points to the north.

Find what happens in the following cases—

1. When the N. pole (as the north-seeking end of the magnet is called) approaches the N. pole of a swinging magnet.

2 When the S. pole approaches the N. pole of a swinging magnet.

3. When the N. pole approaches the S. pôle of a swinging magnet.

4. When the S. pole approaches the S. pole of a swinging magnet.

It will be found that like poles *repel* and unlike poles attract, i.e. a N pole attracts a S. pole, whilst two N. poles repel each other as do two S. poles.

Why does one end of the compass point always to the north? Here explain that the earth is really a gigantic magnet, and one pole is situated in a northerly direction. This explains the attraction of one pole of the magnet. Here it can be shown that the north magnetic pole must be opposite in kind to that of the magnet. Thus, "north-seeking pole" is really a better name than "north pole," for the pole of the compass needle that points north.

Show the card of a mariner's compass. Tell how the different points of the compass are named and show how the compass needle is pivoted.

HOUSEHOLD FITTINGS

The Water System

Why does water flow from a tap? Here explain how water flows downhill. Connect a pipe from water in a vessel at a higher level to one

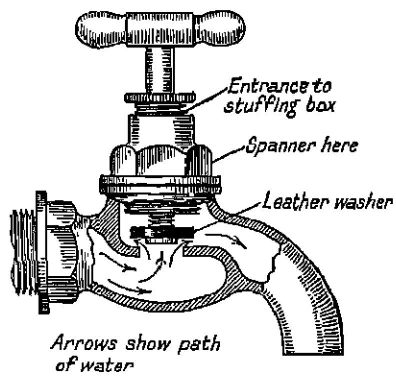


FIG. 12

Diagram of Tap showing Various Parts

at a lower level and show how the water flows from the high level to the lower. From this talk about the position of reservoirs.

How a Tap Works

Procure a tap from an ironmonger's. Before the lesson examine it carefully. Fig. 12 shows its construction. It is quite an easy matter to fit a washer to a tap if the principle is understood. When the water is not flowing it is because the washer fits down over the entrance hole. When the tap is turned on the water can enter the upper portion of the tap and flow out through the spout. After a tap has been in use for some time, it may begin to drip. This is because the edges of the washer have become ragged and a tiny amount of water can pass through, even when the tap is supposed to be turned off.

Fitting a New Washer

Washers cost only a penny or so. The children should be shown how they are put on. This is how it is done Turn off the water at the main if the tap is directly connected to it. If the tap is connected to a tank tie up the ball-cock so that no more water can enter, and empty the tank Now apply a spanner to the middle washer. This generally undoes in the opposite way to that in which the tap turns off. Test carefully, however, before putting much pressure on the spanner. Take out the whole handle and attached parts. It will be found that the washer is attached at the lower end. Unscrew a small nut, remove the old washer. Place a new one in position, replace the nut, and put back the whole in place again.

Sometimes a tap begins to leak through the spindle and body. This indicates that the stuffing in the stuffing box needs replacing. It is made of twine coated with fat.

The Cistern

In the house there are several water cisterns. These hold water for the household supply, for hot-water systems, and for the flushing of lavatories. The water is automatically admitted to them by means of ball valves. The ball valve cuts off the water when it has reached the proper level. The principle on which the valve works is as follows. A hollow copper ball is placed at the end of a metal rod. This copper ball is lighter than water and can float. The metal rod is attached to a valve. Water flows into the tank, the copper ball rises with the water-level and raises the rod. The rod gradually pushes a rubber or leather washer up into the supply pipe. The rod, valve, and ball are so arranged that the valve is quite closed when the ball is floating at the proper water-level required.

Ball valves sometimes go wrong. The cause and cure of some of these may be indicated.

(*a*) The ball may spring a leak, water enters it, and the ball is unable to float on the water. To cure this, remove the ball and look for the hole. When found, make it a little larger so that the water that has entered may be easily shaken out. Clean and solder up the hole.

(*b*) Though the ball floats properly, the water is not stopped. A new washer is needed. In some cisterns this can easily be fitted, in others the services of a plumber will be required.

(*c*) Though ball and washer are in order, the tank either does not fill up sufficiently or too much water is admitted. In this case, the arm has got bent and needs adjustment.

Owing to the danger of water overflowing from an indoor tank, it is usual to fit an overflow pipe that is carried through the walls out of doors. Should water not be cut off, it will then run through the overflow pipe. Notice that the overflow pipe must be larger than the inflow pipe

The Siphon

Many boys experiment with a long rubber tube and transfer water from one vessel to another by its means. When they do this, they are using the principle of a siphon. The teacher should secure a piece of glass tubing bent as shown in Fig 13 To cause the siphon to work, water is sucked through the long end until the liquid begins to flow down the long tube. When the suction is discontinued, water will continue to run out at the lower end. The whole vessel can be emptied as long as the lower end of the siphon tube is lower than the base of the upper vessel and the shorter arm rests on the bottom of this vessel. The device is very useful for emptying water from boilers, etc., which have no lower taps fitted.

If it is not possible to suck the lower end, the tube should first be completely filled with water;

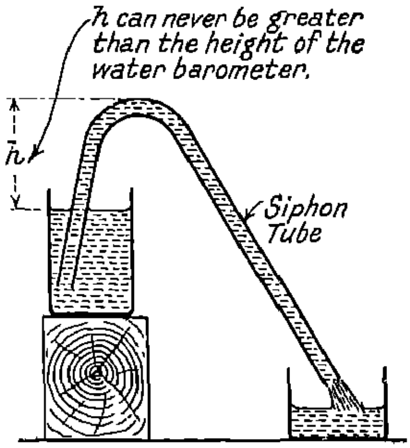


FIG. 13

The Siphon

then, if the ends are covered with the fingers it can be inverted as in Fig. 13. The water will flow continuously then if the operation has been conducted properly. The difference in air pressure in the two arms causes the flow of liquid. A siphon can never carry water over a difference of height greater than the height of the water barometer

Water-Closet Flushing Tanks

These are filled by means of a ball valve as explained earlier. How is it that the water discharges when a chain or lever is pulled? There are various methods, but a common one consists of a siphon inside the tank. When the chain is pulled, a plunger is worked which fills the siphon tube and this starts the water in the tank siphoning. The discharge is through

a large-diameter pipe and is very rapid; the height of the tank from the floor further increases the flushing action of the water

Use of Suction-Pump Principle

Where there is no public water supply, water is often obtained from wells by means of pumps. Children should know something of the way in which a simple suction pump works. Before explaining this, the teacher should give a lesson on three pieces of simple apparatus commonly used: (*a*) a fountain-pen filler; (*b*) a syringe; (*c*) a self-filling fountain pen.

These illustrate one of the elementary principles on which the pump works.

A Fountain-Pen Filler

The glass tube, drawn out to a point at one end, has a rubber cap, something like a baby's dummy in shape, fitted over the other end. This rubber cap is hollow and is very pliable.

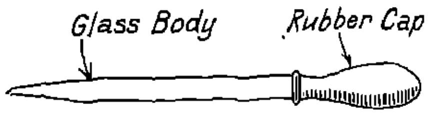


FIG. 14
A Fountain-Pen Filler

When the filler is examined, it will be found to work very simply. Dip the pointed end in water No water can enter the filler because it contains air. The rubber cap fits tightly and so no air can escape at that end. When the cap is squeezed, air is forced out from the pointed end of the filler. This is because the *volume* of the filler is lessened when the cap is squeezed and the surplus air is forced from the narrow end. When the pressure on the rubber is relaxed, the volume of the filler is again increased to its original size. Water rushes in to take up the room which was taken up by the expelled air.

The question may naturally be asked, why does the water rush in now, when previously it did not do so. Here is a simple explanation. When the filler was placed in the water, the air enclosed within it was at the same pressure as the air outside. When the cap was pinched, air was forced out. That remaining within was at the same pressure. When the cap was released the volume of the filler increased, so the enclosed air was under less pressure than before. Thus, the outside pressure was greater than the inside pressure, so that water was forced into the filler until the pressure of the air inside the filler was equal to that outside.

If the rubber cap is pierced so that air can enter that way then the filler is useless, for the air pressure will always be the same inside as the air pressure outside.

A Syringe

A syringe such as that used for washing out ears or for spraying roses works on very much the same principle, but with some difference. Its essential parts are—

(1) *A barrel*, generally in the form of a cylinder brought to a rose or point at one end.

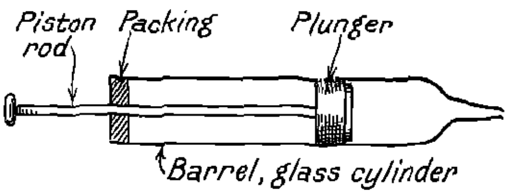


FIG. 15
A Syringe

(2) *A plunger* that just fits in the cylinder; the plunger has an outer wrapping of cotton, leather, or some such substance which, when wet or oiled, makes air-tight contact with the barrel

(3) *A rod* attached to the plunger so that it can be pushed down or drawn back along the barrel.

The nose of the syringe is placed in the liquid and the plunger is pushed down. This forces any air out of the cylinder Then the piston rod is pulled back. There is no air left in the cylinder. If there were, its pressure would be greatly lessened by the increase in volume and liquid would rush in. The liquid will even more readily follow if all the air is driven out. On first using a syringe after it has been out of action for some time, difficulty may be found in drawing in liquid. This is because air enters through the handle side of the plunger.

As soon as the packing swells up with the moisture the syringe will work. Should it not do so, then it will be necessary to repack the plunger or, with some types, to fit a new washer.

A Self-filling Fountain-Pen

For this, the fountain-pen filler idea is used, but in a slightly different form. The barrel of the pen contains a long narrow tube of rubber

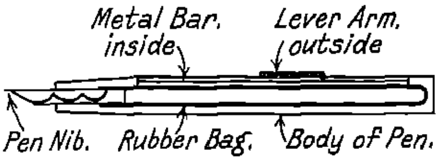


FIG. 16
Self-filling Fountain-Pen

closed at the top end. To the other end a pen is attached. Fitted close to the barrel inside is a long rod of metal. This is attached to a lever arm on the outside of the pen. When this arm is lifted, the rod of metal presses against the rubber bag and squeezes the air from within it. If the pen is placed in ink and the arm is lifted, then air bubbles can be seen coming from the pen point. When the arm is lowered, the pressure on the bag is released and so ink enters the pen.

The Simple Pump

This works on the lines of these last three articles. The essential parts of a pump are—

(1) *The barrel* or cylinder—this is connected with the water supply by a pipe at its lower end, the other end can be open; near the top on one side is an outlet pipe.

(2) *The piston* or plunger, which fits the barrel, but has a valve in it which opens when the piston is pressed *down* but closes when the piston is raised;

(3) *A valve* placed over the pipe which communicates with the water source, this valve closes when the piston is pushed down and opens when it is raised.

The pump works as follows.

1. The piston is forced down to the bottom of the cylinder (by a handle or other means). This it can do easily because the valve opens and the air in the barrel escapes. The valve on top of the pipe from the well is closed.

2. The piston is raised. The valve in the piston is closed, but the inlet valve opens so that water rushes up into the barrel.

3. The piston is pushed down The water in the barrel cannot escape because the lower valve closes. The water passes through to the top side of the piston.

4. The piston is raised. As the valve on top of the piston is shut the water is raised. When it reaches the outlet pipe near the top of the barrel it rushes out.

Figs. 17 and 18 demonstrate the process.

A pump of this kind cannot raise water from any depth. From an examination of the diagrams it will be seen that air pressure really holds up the water. Theoretically, it should be

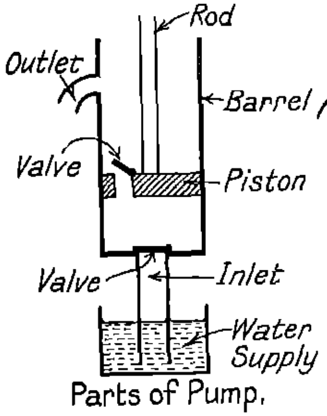


FIG. 17
Section Diagram of Pump

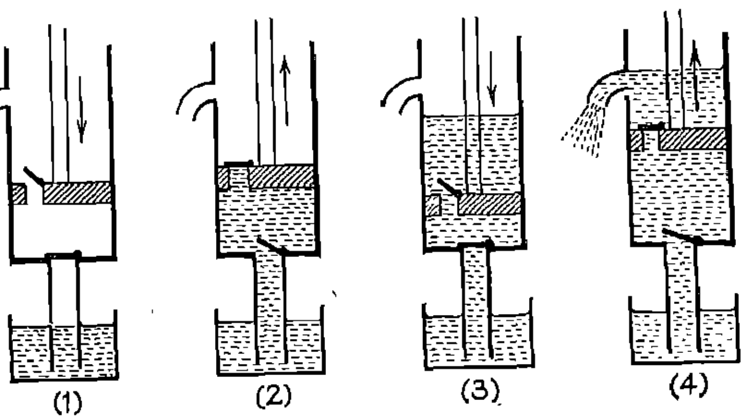


FIG. 18
How a Pump Works

possible to raise water 34 ft. Owing to leaks, etc., it is usual not to attempt to raise water more than 25 ft. by this method. The force pump and other methods are used for greater depths. These are outside the scope of the Junior School syllabus.

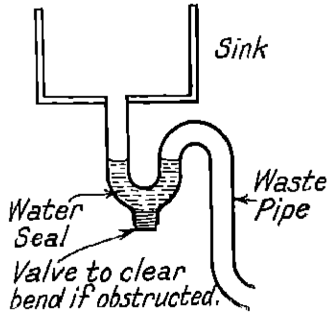


FIG. 19
A Sink Trap

Sink Traps

Under most kitchen sinks, the shape of the pipe which carries off the waste can be examined. It is in the form of a U-bend. Water is trapped in the U-bend (Fig. 19) and thus prevents draughts, evil-smelling gases, and similar unpleasant smells entering the house. A removable cover is provided at the bend so that obstructions may be cleared when necessary.

HEATING AND LIGHTING IN THE HOME

Many valuable lessons can be taught on this subject.

Matches

These are very cheap, even now. Before the Great War of 1914-18, a dozen boxes could be bought for a few pence. At three halfpence a box the early Victorians would have welcomed them. Throughout history, Man has always wanted to find easy methods of making fire.

The children can be shown how heat is generated when a stick is rubbed quickly along a groove in a board. This was one of the primitive methods adopted. Whirling the stick round in a groove by means of the hands or a bow cord was another method. Then the hard flint stone was struck with a piece of steel and the resultant sparks were allowed to fall on tinder, a dry form of rag or even rag ashes. The first match was probably made in 1805 by a Frenchman. Various chemicals were fixed to the end of thin pieces of wood. A small bottle containing asbestos and acid was supplied. When the tip of the match was applied to this, the match ignited. It is impossible here to give a full history of the match. The children must observe that there are *two* types of matches sold to-day—

(1) Those that strike anywhere;

(2) Those that strike only on a specially-prepared surface.

The teacher should then explain the differences. Those that strike anywhere contain phosphorus, amongst other chemicals, on their heads. The action of rubbing the match head against a rough surface causes heat by friction. This heat ignites the chemicals. This, in turn, causes the stalk of the match to burn In order to aid the wood to burn quickly, it is well dried and sometimes treated with paraffin wax.

Originally, *yellow* phosphorus was used in match heads. This form of phosphorus is deadly poison and many children were poisoned by sucking the match heads. Further, workmen engaged in the match industry developed a disease of the jaws *Safety* matches, which strike only on a chemically-prepared surface placed on the side of the box, contain *no* phosphorus in the heads The phosphorus is on the box, and is of the red, non-poisonous form.

Modern matches have another advantage If a match is struck, used, and then thrown away, there is danger of fire from the glowing end of the match. Scientists have found that if the stalks are soaked in a mixture of phosphoric acid and ammonium phosphate, the match does not glow after the flame is extinguished.

A very interesting exercise for children is to make a collection of matchbox lids and notice from which countries matches may be obtained.

The modern use of flint in lighters for cigarettes and gas-stoves may be mentioned.

The Candle

This is still a useful portable light. Early candles were made by dipping wicks into melted tallow a number of times. Each layer of fat was allowed to cool before the next dipping took place. The "dip" was immersed in the melted fat until it was of the required thickness. These candles gave a smoky flame, and, because glycerine was contained in the fat, emitted unpleasant

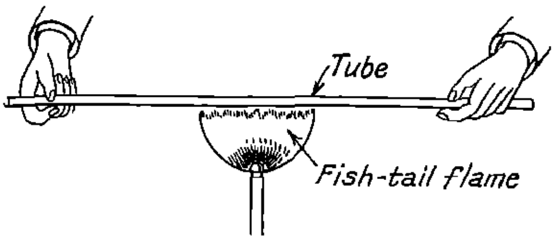


FIG. 20
Making a Capillary Tube

odours. Church candles were made from beeswax. Modern candles are made from fats from which the glycerine has been removed by chemical methods.

Capillary Attraction

Why does a candle burn? If a light is applied to the wick, the wick begins to burn The heat of the burning wick melts a little fat on the

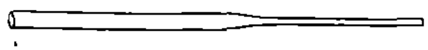


FIG. 21
A Capillary Tube

top of the candle and the wick itself becomes hot. Liquid fat then rises through the wick to the flame by capillary attraction. The teacher should explain and illustrate this term by two experiments.

1. Draw out a glass tube so that it becomes very thin. The easiest way to do this is to hold the centre of a glass tube in the flame of a fish-tail gas burner. The tube should be rotated. After a time the glass will become molten and, on pulling the hands apart, it will be found that the tube is drawn out. Carefully snap the tube in the middle. Thus, two tubes are now available, each with one end drawn out very thin. Dip the thin end in red ink. It will be observed that the ink rises to quite a high level in the narrow tube. The more narrow the tube, the higher will be the level.

2. Obtain two old photograph plates, from which the film has been removed, or two sheets of glass Bind them together by means of an elastic band at each end. Prop them apart at one end with a thin card. Dip the two pieces of glass held together in a saucer of red ink. The ink will rise higher nearer the closed end.

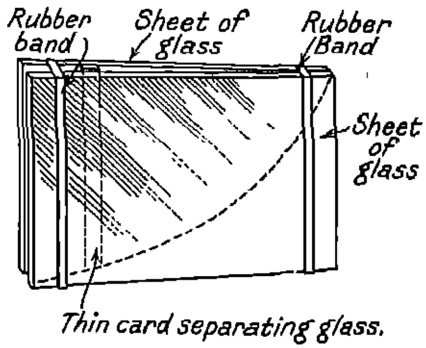


FIG. 22
An Experiment to show Effects of Capillarity

Oil and melted fat ascend through wicks by this principle of capillarity.

The Candle Flame

This is extremely interesting and should be examined. The children should name each part and make a coloured drawing of it.

The four zones to be observed are as follows.

1. The yellow luminous flame.

2. The dark inner zone—no burning is taking place there because air cannot reach it.

3. The hot, almost invisible flame surrounding the yellow portion. A match head held in this will quickly ignite.

4. The blue coloration at the base of the flame

One other interesting thing about a candle is the wick. In the olden days, the burnt wick had to be removed with snuffers The black

debris of the wick caused the flame to burn poorly and was generally a nuisance Scientists have now found that if the wick is woven in a special way there is no longer any need to snuff the candle. A twist is given to the cotton, so that as the wick burns down, the burnt, black part (which is carbon) protrudes into the hot

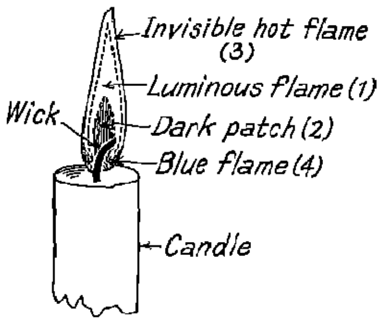


FIG. 23
A Candle Flame

in visible flame. Here, in the presence of air, the heat converts it into a gas and it is destroyed

Oil Lamps and Stoves

These work very much like the candle. Oil from a reservoir ascends the wick by capillarity. Heat converts the oil to a vapour, as it does the fat in the candle, and the vapour burns.

The first improvement in lamps came with the invention of the circular burner by Argand. Air could rise through the central hole and help all the vaporized oil to burn. When an oil stove or lamp gives off an unpleasant smell, it is because some of the oil vapour is remaining unburnt. Lamp glasses also help and control combustion.

Incidentally, the invention of the petrol engine has made the price of paraffin less. This may seem strange, but it can be explained briefly. Petrol is obtained by distilling crude mineral oil. At a fairly low temperature, petrol vapour is given off, passed to a condenser, and turned back into pure petrol. If the remaining oil is heated to a little higher temperature then paraffin vapour is obtained. This can be condensed into paraffin. Now, if there is a world demand for petrol, then a considerable amount of paraffin will also be available.

Scientific research has resulted in some very efficient oil stoves and cookers which use this paraffin very effectively. The teacher might obtain a Valor Perfection, or similar stove, and show the burner. In this type of burner, *air* is

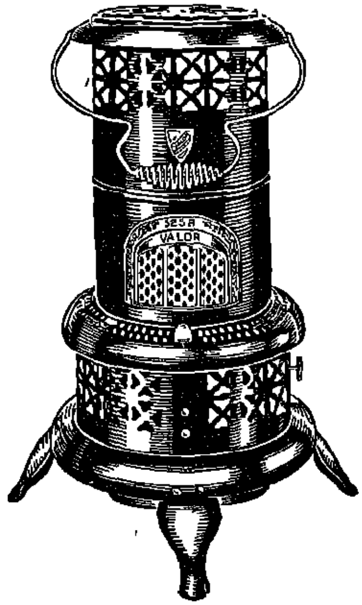


FIG. 24
An Oil Heater

made to mix very intimately with the vaporized oil: the flame, instead of being luminous, is almost invisible and very hot. The reason for this will be explained in the section on gas.

Coal Gas

Gas was first used as an illuminant in 1770. A Scotsman, William Murdoch, who lived at Lugar, in Ayrshire, when a boy, found an outcrop of coal in his father's garden. He heated this coal up in an old boiler and lit up a cave by gas. Later, when working for Watts, the famous engineer, he remembered his early experiment. He lit his office with gas in a similar manner. A Frenchman named Lebon and a German named Winsor also discovered the same thing about 1800. The teacher should make

coal gas in the classroom. This is most easily done by heating some small coal in the bowl of a churchwarden clay pipe After the coal has been placed in the bowl, the bowl should be sealed with clay (not plasticine). The bowl is then heated, and after a time gas will issue from the stem and it can be lighted.

There is no occasion to describe all the methods by which crude gas, similar to that which issues from the pipe stem, is purified. Suffice it to say that in a gas works the coal is heated in retorts and the gas is washed and passed through various chemicals to make it fit for use in homes and factories. Coal-tar and other valuable by-products are obtained, and coke, which is a very good fuel, is left in the retorts. Some coke will be found in the pipe bowl.

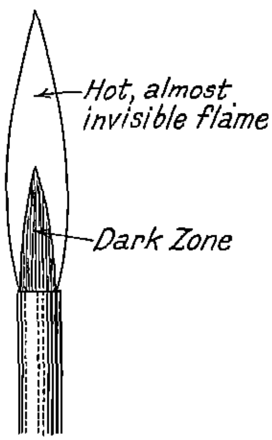


FIG. 25
Luminous Flame

Luminous Flame

When gas is lit at an ordinary burner, it gives a flame very similar to that of a candle; the four zones can be picked out. If a piece of paper is held momentarily in the luminous part of a candle or gas flame, it will be found that a deposit of black soot-like substance is left on the paper. This is unburnt carbon. The luminosity of the flame is caused by these particles being made white-hot. Thus, it is clear that all the matter contained in the gas or candle flame is not consumed.

Hot Flame

If the flame given out from a gas ring is examined, it will be noticed that it is practically non-luminous Why is there this difference between the flames of the fish-tail burner and the stove? Examination of the stove burner or gas ring will show that there is an opening in the gas inlet pipe which allows air to enter with the gas The gas, rushing in under pressure, sucks in this air. The additional air assists combustion and all the carbon particles are burnt up and converted to carbon dioxide or carbon monoxide by union with oxygen. This addi-

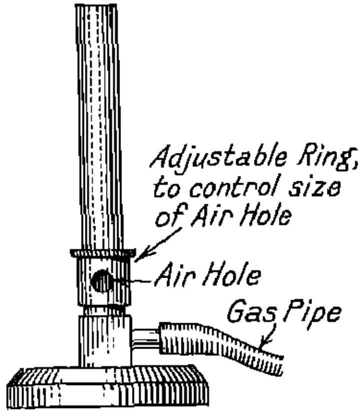


FIG. 26
A Bunsen Burner

tional combustion causes the flame to be non-luminous, but much hotter. This principle of admitting air into the inlet pipe was the discovery of the German chemist Bunsen. Such burners are termed bunsen burners for this

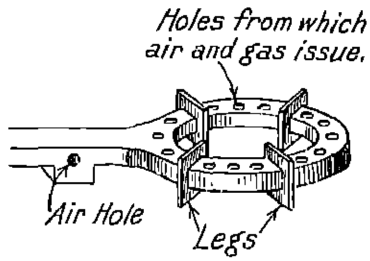


FIG. 27
A Gas Ring

reason. For cooking and heating purposes they are ideal, but, of course, they are useless for illumination

The Gas Mantle

In 1885, Auer Von Welsbach invented the incandescent mantle. It was an accidental discovery. Welsbach had been experimenting with

some of the rare metals. He had been dipping a platinum wire in a solution of some chemicals containing these metals, and had been then heating the wire in a bunsen flame. He then dipped some cotton wool into these chemicals and ignited the cotton wool. He found that a new compound of the metals was formed as an ash, and that this ash glowed very brightly when held in the bunsen flame. The idea occurred to him that if such a substance could be held in a bunsen flame, it would become white-hot and give out a light which would serve as an illuminant. Thus, the first gas mantle was invented.

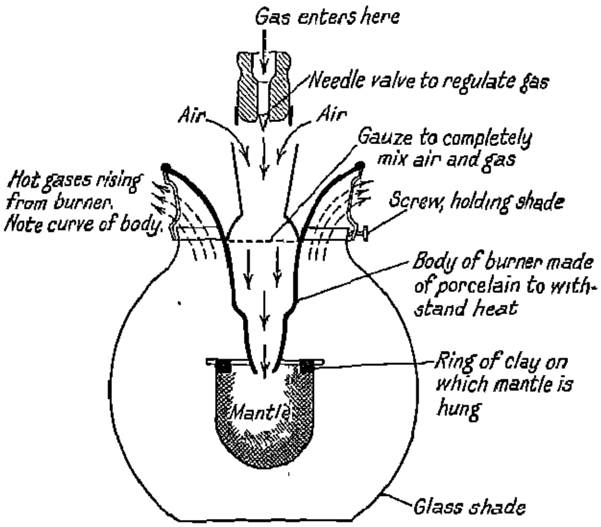


FIG. 28
Section of Inverted Gas Burner

The method of making a gas mantle is interesting. A knitted tube made of cotton, ramie fibre, or silk is cut into lengths. One end of each length is gathered up with asbestos thread and a small loop is placed across the centre. The mantle is then dipped in a solution of 99 parts of nitrate of thorium and 1 part of nitrate of cerium. After the dipping, the stocking is wrung out and shaped on a cone. The mantle is then burnt off. The light is applied at the top and the flame spreads downward. Only the ash of the fibre and the chemicals in which the fibre was soaked is left. This ash is then hardened off in a bunsen burner. Such mantles are delicate and would not travel far without breaking. As a protection the mantle is coated with collodion. When the mantle is fixed over the burner a match is applied to it and it catches fire. The flame is caused by the burning collodion. The teacher should show examples of gas mantles and explain the process of manufacture. A little of the mantle held in a bunsen burner will give out white light.

The inverted mantle has an advantage in that there is no shadow of the gas fittings beneath it. Thus, a better light is given. Scientists spent considerable time in perfecting the burner used in connection with the inverted mantle. Such a burner may well be shown to children and the various parts explained.

Electric Light

It will not be possible to teach Junior School children a great deal about the way in which electricity is generated. It will be sufficient to tell them that current electricity is made in one of two ways—

1. By means of dynamos. These consist of large and complicated machines in which coils of wire revolve between the poles of very powerful magnets.

2. By chemical action. If a piece of copper and a piece of zinc are stuck in a lemon and the copper and zinc are joined with a piece of wire, then electricity will pass along the wire. If the wire is broken in the middle and the two ends are placed about $\frac{1}{8}$ in. apart on the tongue, the effect of a tiny electric current can be felt.

Electricity passes in a complete circuit in all cases.

A Flash-lamp

Detailed examination of this favourite possession of young children will give several important lessons. It consists of—

(1) A case into which a "dry" battery will fit and a special switching device;

(2) A small electric lamp,

(3) A dry battery.

First examine the *battery*. Notice that its internal structure cannot be seen, but two brass strips protrude from within. One strip is longer than the other. If the tongue can be placed so that contact is made with the two strips then, if the distance apart is small enough, current can be felt to be passing.

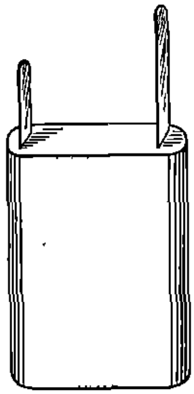


FIG. 29
A Flash-lamp Battery

The lamp consists of a bulb of glass inside which a thin spiral of wire can be seen. The holder consists of an outer metal screw. At the base of the screw is a central stud of metal surrounded by some black substance. It should be explained that one end of the inner spiral of wire, or filament, is attached to the metal screw on the lamp and the other end to the central stud. The substance surrounding the stud is called an insulator, and will not let electricity pass through it.

To Light the Lamp

The long metal strip in the battery is bent over, so that when the battery is pushed up

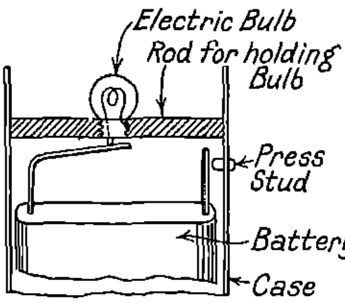


FIG. 30
How the Circuit is Made

into the case, then the central stud touches it. On the side of the case is a knob which can be pushed up and down. When in one position it touches the short strip from the battery. In this position electricity can flow from one strip through the lamp filament, out through the screw, down the case to the other strip and back through the battery. This is a complete circuit. When the knob is moved, the metal strip does not touch the case and the electricity cannot flow.

What Causes the Light?

When electricity passes through some substances, especially if they are very small in cross-section, resistance is experienced by the current. This resistance causes heat in the wire, and the wire becomes so hot that it gives out a white light; it is what is known as white-hot.

What is Inside the Battery?

When a dry battery is no longer of use in a flash-lamp, then it can usefully be taken to

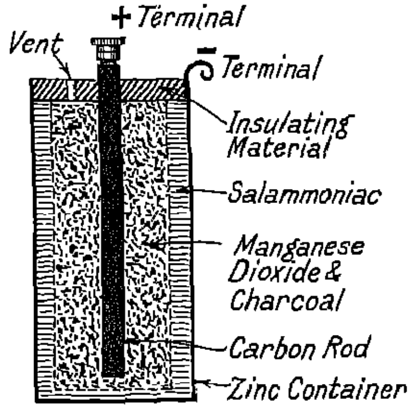


FIG. 31
Inside of "Dry Cell"

pieces and examined. It will be found that it is made up of three separate cells. Each cell contains (*a*) an outside shell made of zinc, (*b*) inside a mixture of chemicals, (*c*) in the centre a rod of carbon. As all batteries are not constructed alike, it is not possible to generalize, but the chemicals consist of sal ammoniac often mixed with plaster of Paris near the zinc, and manganese dioxide and powdered charcoal near the carbon rod. The carbon rod, charcoal, and manganese dioxide are sometimes separated from the other chemicals by being placed in a small bag.

It is rather difficult to explain to children why there are three cells in each battery. Suffice it to say that the three cells are arranged so that the pressure of electricity is greater. One cell could not supply sufficient power to raise the filament to white-heat. In connecting the cells together, the carbon of one is fastened to the zinc of the next. The brass strips which come out of the battery are joined to the first zinc and the last carbon respectively.

The Electric Lamp Bulb

The lamp used in the home is very similar to that in the flash-lamp There are (1) the glass bulb, (2) the fine filament, (3) the cap Examination of the base will show *two* metal studs. Each is connected to one end of the filament, insulating material being placed between.

In early kinds of electric lamps, all the air was pumped out before the bulb was sealed. This was so that the filament should not combine with the oxygen of the air and gradually be burned away. Some vacuum lamps are still manufactured, but others are filled with *nitrogen* or *argon*. These gases will not join with metal, and there are other advantages in filling the bulbs with such gases.

The lamp holder should be examined. There is no need to explain its construction fully here. Notice. (*a*) The two small knobs on the outside of the lamp case which slide down into the holder, and are kept in position by rotating the lamp slightly so that the knobs engage in slots provided; (*b*) that two brass studs make contact with the two studs on the lamp base, (*c*) that the circuit is completed when the studs engage.

The teacher should also obtain from a friendly electrician examples of various switches and show how these work.

The Electric Stove, Kettle, and Iron

These all work on the same principle Electricity passes through special coils of wire made of nichrome, an alloy of nickel and chromium, which are not affected by air. The teacher should show examples of these.

The Petrol Lighter

This small piece of apparatus is used by smokers to get a light without using matches In essential, it consists of three parts.

1. *A small tank of petrol.* The tank is filled with loosely packed cotton wool, and the wool is soaked with petrol. This prevents accidents which might occur from spilled spirits. Petrol is chosen because it turns into vapour very readily

2. *A piece of wick*, leading from the petrol chamber and held in a circular rim of metal A cap can be placed over the top when the lighter is not being used to prevent evaporation of the petrol.

3. *A flint and steel* to make a spark. This consists generally of a steel wheel with a ribbed rim, with a piece of flint pressing against it. When the lighter is opened, the movement of the lid turns the steel wheel against the flint, sparks are caused, the vaporized spirit ignites, and the wick burns. In some lighters, the wheel is rotated with the thumb.

The Gas Lighter

Much simpler than the petrol lighter, this practically consists only of the steel wheel and flint. In some cases, the apparatus is in the form of a pistol. When the trigger is pulled, the wheel revolves against the flint, sparks are made, and when "fired" into the gas cause it to light. The teacher should show both petrol and gas lighters to the children and demonstrate the method of renewing the flints

An Acetylene Lamp

Acetylene gas is given off when water acts on calcium carbide. This gas was known to chemists for some years before, in 1892, two scientists discovered the method of manufacturing it on a large scale They found that if anthracite coal and lime were fused together in an electric furnace, a substance known as calcium carbide was formed. When water was added to this, a gas, acetylene, was given off. The teacher should obtain a tin of calcium carbide and point out to the children why the container is made airtight. That gas is formed on

adding water to a lump of carbide can be demonstrated in a saucer. The evil smell is caused by an impurity. The pure gas is practically odourless.

In an acetylene bicycle lamp there are several important parts—

1. *The water container* occupies the top portion of the body of the lamp. A needle valve is provided to control the amount of water which can drip out at the bottom.

2. *The calcium carbide container* is below the water chamber. Up the centre is a metal tube containing a number of holes. The water valve fits into this so that the water enters the carbide compartment sideways and at various levels. Carbide is placed in the container to about half-way up, and a plate, which has a spring attached to the upper side, fits over the chamber

3 *The burner* communicates with the upper part of the carbide container.

4. *A case* with a glass front is fitted round the burner and a reflector is placed behind it.

The carbide container screws up tightly to the water container and a rubber washer makes the junction airtight The spring makes the inner plate keep the carbide pressed well down When the water is turned on, it drips into the lower compartment and comes in contact with the carbide. Acetylene is given off and passes through a filter pad into the burner, where it is lit. The carbide is converted into slaked lime. This slaked lime takes up more room than the

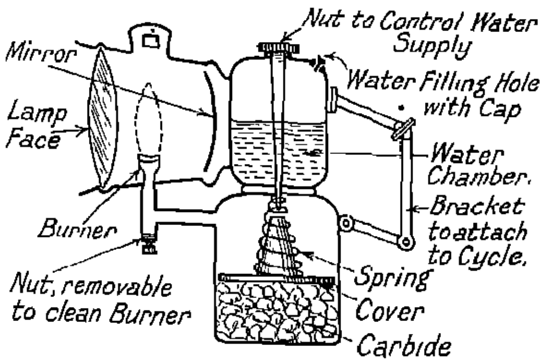


FIG. 32

Section of an Acetylene Lamp

original carbide. This is the reason why the container is only filled half-full of carbide.

Care must be taken to keep the lamp clean, the burner holes quite clear, and the delivery tube free of obstruction. There will be no danger of an explosion if this is done.

SOME HOUSEHOLD ACCESSORIES

Meter Readings

A useful lesson can be given on the methods of reading various kinds of meters used in the home.

Gas Meters

The gas supplied to the home is sold at so much per cubic foot, and it is usual to charge only for the nearest thousand feet when sending in the bill. There are two types of gas meter in use.

1. *The wet meter* was the first form invented. A horizontal cylinder was made to revolve inside another cylinder The revolving cylinder had four compartments and was covered with water to just above the axis. Gas entered under the water and filled a compartment. This, being lighter, then rose. When above the water, the gas was conducted from the meter to the house

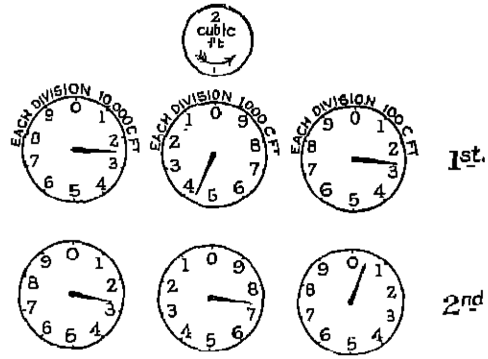


FIG. 33

system. Thus, the number of revolutions made by the inner cylinder measured the gas used.

This form of meter is very accurate, but requires constant attention as the water level must be maintained and the water must never be allowed to freeze.

2. *The dry meter* consists of a case containing a pair of cylindrical bellows and clockwork apparatus. The gas pressure alternately fills and empties the bellows. The number of times this is done indicates the amount of gas used and is recorded on a dial.

The dial consists of a number of little clocks. Fig. 33 shows how these are read. One thousand cubic feet can be measured on the right-hand dial, 10,000 cub. ft. on the middle one, and 100,000 cub. ft. on the left-hand one. A little dial, which registers cubic feet only, is used to check the meter for leakages.

The Electricity Meter

Electricity is sold by the unit. The unit of electricity is a standard set up by the Board

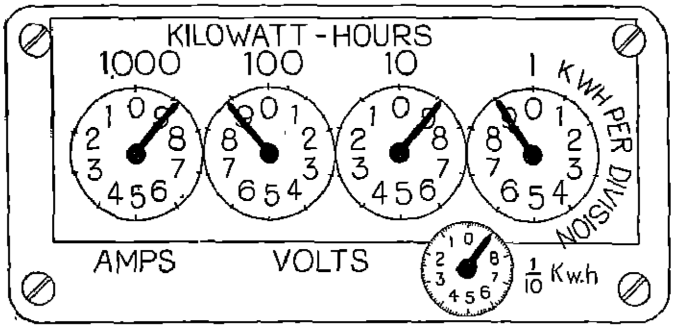


FIG. 34

of Trade and is called the "kilowatt-hour." It is the amount of work done by 1,000 watts of electricity in one hour. There is no need to attempt to explain the unit, however, to children in Junior Schools.

In some types of meter there are four dials in a row. Each dial is divided into ten divisions. Each division on the dial to the extreme right measures kilowatt-hours, the others tens, then hundreds, and finally, thousands of kilowatt hours. A small dial in one corner gives tenths of units and is used to check the correctness of the meter.

Fig. 34 may be copied on the board, and the children can be shown how to read the meter.

Water Meters

In the homes of most of the children, the water is supplied by the Water Company at a

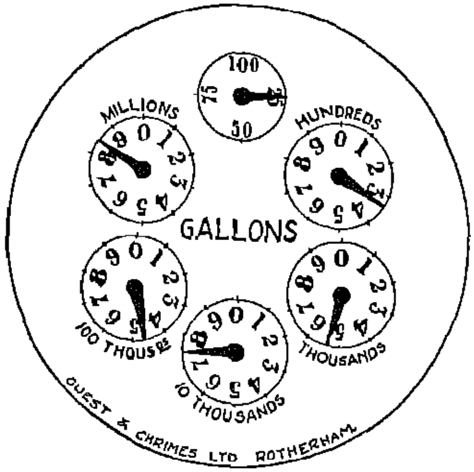


FIG 35

fixed rate per quarter or half year. This price depends on the size of the house, the number of bathrooms, etc. Large works, however, pay for the water they use at so much per thousand gallons. Such factories must install meters to measure the amount of water used. Much skill and ingenuity have been given to the designing

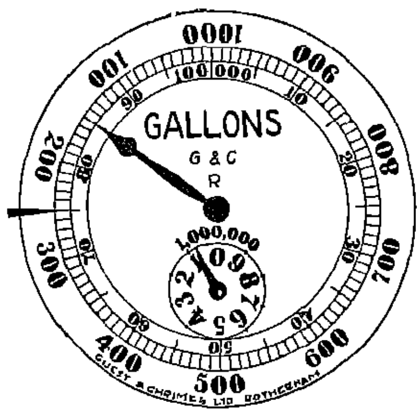


FIG. 36

of such meters. In one form, a piston measures out a definite amount of water at each stroke and the number of strokes are indicated on a dial. The propulsion is given by the water pressure. The other type has a number of small vanes projecting from a spindle. The force of water drives this little turbine round. The number of revolutions indicates the amount of water used. A filter is generally inserted before the turbine so that nothing shall get into the meter to injure the working parts. The dials of water meters vary. Figs. 35 and 36 show both types. In one the little clocks are similar to those found on a gas-meter dial In the other type, the dial rotates, and a pointer remains fixed. A revolution of the dial causes other pointers to move.

An Electric Bell

Various points have to be explained before the principles involved in this are understood. It can be made the subject of several interesting lessons.

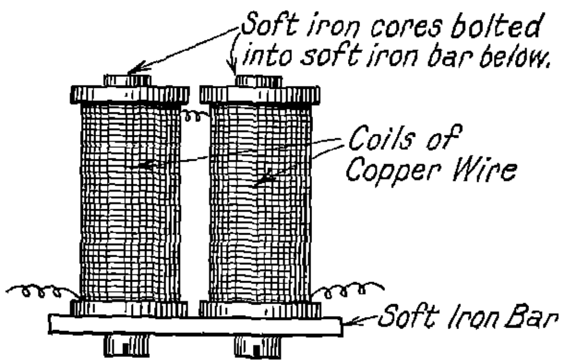


FIG. 37
A Simple Electromagnet

Electromagnet

First, it is necessary to illustrate the principle of the electromagnet.

Apparatus required: Soft-iron nail, a long length of covered copper wire, and an electric cell, and some tin tacks and needles.

Wind a length of silk- or cotton-covered wire

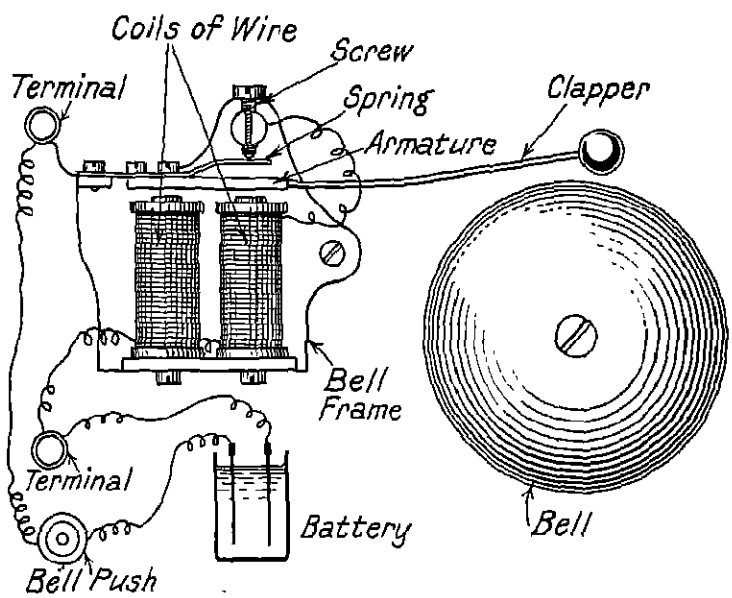


FIG. 38
Parts of an Electric Bell

round the nail so that the coil covers it. Connect one end of the wire to one pole of the cell. Hold the nail end just above a needle. Touch the other battery pole with the free end of the wire. Notice that, immediately, the needle is attracted to the nail, which has become a magnet. When the wire end is removed from the pole the needle falls, because the current is cut off and the nail loses its magnetism. Thus, the children see that when a wire carrying a current passes round a piece of soft iron (or steel) the iron or steel becomes a magnet. (Do not attempt to explain why at this stage.) Notice soft iron is used as the "core" because it readily becomes magnetized, and rapidly loses it when the current is cut off. Steel is more slowly magnetized, but retains its magnetic properties longer.

A Make-and-Break Fitting

The electric bell contains a soft-iron core, wrapped with covered copper wire. The bell

clapper is fitted to a piece of iron. When the circuit is completed, the iron is attracted to the magnet, carrying with it the clapper, which hits a gong. Now, if the current passed *all* the time, the clapper would bang the gong *once* and would remain against it. This would not be much use for an alarm signal. So a device must be introduced to make the current circuit complete and then to break it again and to keep doing this. This device, for reasons which now appear clear, is called a "make-and-break." In the electric bell this is done by attaching a small steel spring to the back of the iron which carries the clapper. The electric current passes along a screw through the spring and completes the circuit. When the bar (or *armature* as it is called) is pulled towards the magnet, the spring can no longer make contact with the screw, so the circuit is broken. The soft-iron is no longer a magnet and back flies the armature. Now, the spring makes contact with the screw, the current is restored, the magnet again exists, so the armature is attracted. Thus, a continuous hitting of the gong is caused. (See Fig. 38.)

A Thermos Flask

The study of this leads to the teaching of some common facts about the transmission of heat.

Conduction of Heat

Heat a flat iron. Place it on a piece of cold metal. Notice that heat passes from the hot iron to the cold metal. Other examples can be given of heat passing from a hot body to a body at a lower temperature. Place a piece of copper and a piece of glass in the flame of a gas jet. Notice that heat passes from the flame along the copper, but it does not do so readily along the glass. Thus, copper is a better conductor of heat than glass Obtain two hot-water bottles. Fill them with very hot water. Wrap one in several layers of flannel Place the other on a sheet of copper. Feel the temperature of the two bottles after one hour. That wrapped in flannel is very much the hotter. Flannel is a bad conductor of heat and, therefore, much heat could not escape from the bottle. In the other case, the copper conducted more heat from the bottle, the air took more, and so the bottle rapidly cooled.

Construction of the Flask

The thermos flask is an invention which is used to keep very hot liquids hot, or very cold liquids cold. The liquid to be so preserved is placed in a receptacle which is surrounded by a very bad conductor of heat. Thus, no heat

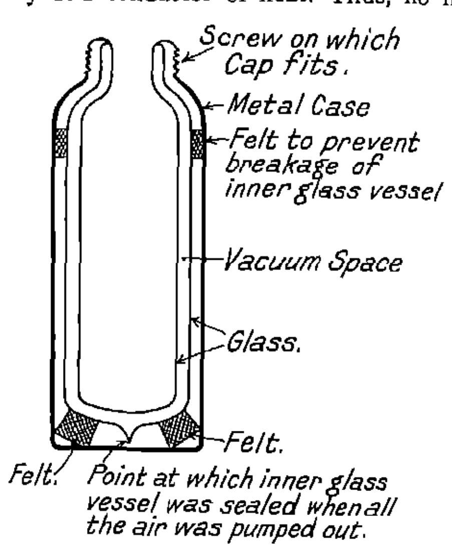


FIG. 39

Parts of a Vacuum Flask

(or very little at any rate) can escape from a very hot liquid, nor can any heat reach a cold one. The bad conductor chosen is a vacuum, i.e. a space out of which all the air has been pumped Some heat might still escape by what is known as radiation. Gas fires, red-hot coal, and even the sun send out their heat in invisible rays. To prevent loss in this way, the inner surface is silvered so that the heat rays are reflected back into the liquid.

A Fire Extinguisher

Hand extinguishers are kept in most schools. The children should have some idea of how a common type works. First, it is necessary to show the effect of the gas carbon dioxide on a flame.

Carbon Dioxide

This gas, which is invisible and heavier than air, has a slightly sweet taste but no odour. It is easily made by acting upon marble with hydrochloric acid. When a glass of health salts is prepared, the liquid effervesces. The gas given off is carbon dioxide. The health salts consist of a carbonate and an acid in a dry state. When mixed with water, the acid acts on the carbonate and carbon dioxide is given off. As the gas is heavier than air, the teacher can obtain a jar full quite easily. Place a teaspoonful of health salts in the bottom of a glass jam jar. Pour on a little water. The salts effervesce and carbon dioxide is made. The air is driven out of the jar and the heavier carbon dioxide remains. Cut a long splinter of dry wood. Light it. Plunge it into the jar and immediately the splinter is extinguished. Light a candle. Pour a jar of carbon dioxide out over the candle just as if it were full of water. The carbon dioxide, being a heavy gas, falls downward on to the candle and the flame is extinguished.

Now a fire extinguisher is a piece of apparatus which generates a supply of carbon dioxide quickly. The gas forces out a stream of water. This water has a considerable amount of carbon dioxide mixed with it. The water and the gas together effectively put out a small fire It should be said that the gas carbon dioxide will dissolve to some extent in water.

How an Extinguisher Works

The essential parts of a fire extinguisher are—

1. The container—generally conical in shape. Down the centre is a perforated cylinder. The nozzle at the top is placed so that it is out of the way of any liquid.

2. The sealed glass tube of sulphuric acid, which fits in the top of the internal perforated cylinder.

3. A weight which fits in the bottom of the cylinder and can slide along it.

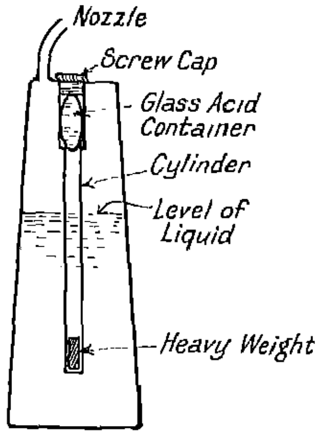


FIG. 40
Parts of a Fire Extinguisher

4. The liquid, which is some carbonate, e.g. bicarbonate of soda, dissolved in water.

When the apparatus is inverted the weight slides down the tube and breaks the base of the acid tube. The acid immediately mixes with the solution of bicarbonate and carbon dioxide is made. The gas forces the liquid out of the nozzle.

Recharging

To recharge the extinguisher, wash it out to remove all traces of acid, and fill up with sodium bicarbonate solution; put in a new acid container, close the lid, and hang up.

CYCLING AND MOTORING

This section deals with a few common objects utilized in motoring and cycling. No attempt will be made to explain the working of the internal combustion engine, which is too difficult for Junior School pupils.

Tyres

Bicycle tyres were originally made of solid rubber. This rim of rubber was held on by wires embedded in it or by beads engaging flanges.

The modern pneumatic tyre was invented, it is thought, in 1845, by R. W. Thomson, but the practical application of it to the bicycle was made in 1888 by J. B. Dunlop There are two parts to a motor and a bicycle tyre: (1) the inner tube of rubber which contains the air; (2) the outer cover.

The outer cover is made of a basis of canvas threads embedded in rubber. The outside consists of pure hard rubber. A pattern is generally impressed on the outer "tread," so that chances of skidding or slipping on wet and greasy surfaces are lessened.

The inner tube is a continuous cylinder of rubber which first fits round the wheel. In order that air may be forced into the tube, a metal tube is placed so that it juts from one point on the inner circumference of the outer surface. A hole is made in the wheel rim, through which this tube fits. A special valve is screwed into this tube. The valve is so made that air can be forced into the inner tube, but cannot come in the opposite direction.

The Cycle-Tyre Valve

This consists of a central piece of metal shaped as shown in Fig. 40. An air pump can be

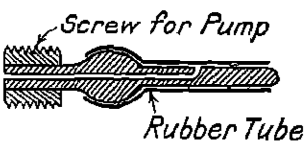


FIG. 41
Tyre Valve

screwed on one end. The air which passes in through the valve goes through a small hole on its lower end. This hole is covered by a thin sleeve of rubber. A puff of air forced in by the pump lifts the rubber and so enters the inner tube. The air within cannot escape as it presses the rubber firmly over the hole.

The Cycle Pump

This is used to force air into the inner tube. The teacher can easily obtain several cycle pumps and take them to pieces to show the class the various parts. The main parts are—

1. *The barrel*, which consists of a cylindrical tube made of plated steel or iron, or of xylonite

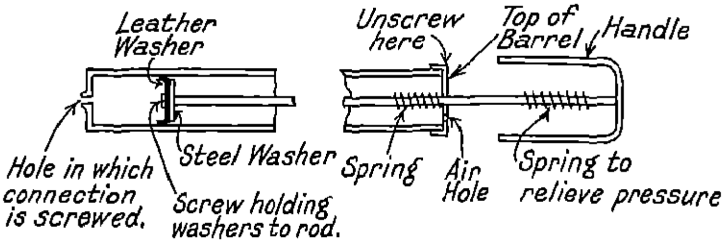


FIG. 42
Parts of a Cycle Pump

(celluloid). The iron is plated with nickel to prevent rust. Celluloid is made by uniting nitrocellulose with camphor. This form is very inflammable. Recently, a non-inflammable variety of celluloid has been made by using cellulose acetate instead of nitrocellulose. The barrel has a plate at each end. At one end a small screwed hole is placed in the centre of the plate. The pump connection which joins the pump and the tyre is screwed in here At the other end is a hole through which the plunger handle passes. Another small hole is also made in the plate to admit air, so that the plunger can be pulled back easily. The plate through which the plunger handle passes can be unscrewed.

2. The remainder of the pump consists of (*a*) *a handle*, (*b*) *a piston rod* joined at one end to the handle, and (*c*) *the plunger*.

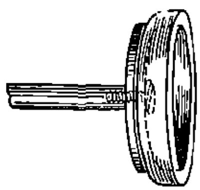


FIG. 43
Enlarged Drawing of Pump Washer

The plunger is made generally of a soft well-oiled leather washer which fits freely in the barrel. This is screwed to the piston rod with a screw and is kept rigid by a steel washer behind it. A spring is placed on the rod quite loosely. When the handle is pulled back a

violent knock on the back of the steel washer is prevented by the action of the spring. Similarly, a spring is placed in the top of the handle, so that on the down stroke a violent blow is not given to the front of the washer. The shape of the leather washer should be noticed particularly,

To Use the Pump

A rubber connection is screwed into one end of the pump and on to the tyre valve. The pump handle is pressed down and air is forced into the valve. When the pump handle is pulled up, the

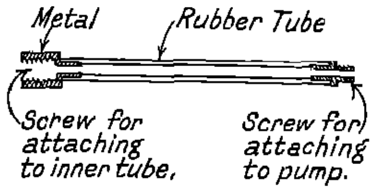


FIG. 44

Connection between Tyre Valve and Pump

shape of the leather washer allows air to pass by it, thus preventing a vacuum Air is admitted to the top of the barrel by a small hole. The teacher should show the change in shape of the leather washer on the down and up strokes.

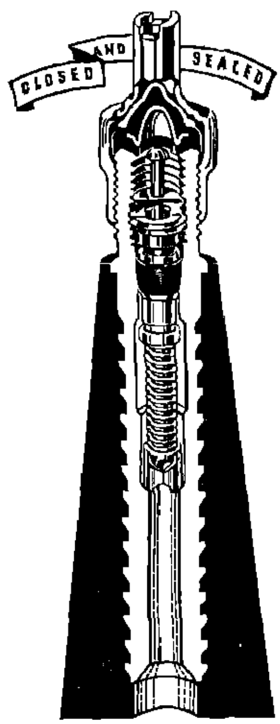
What is a Puncture?

After a tyre is "blown up," it will be quite hard. The air forced in is exerting pressure on the inner tube which in turn pushes the outer tyre outward. If a small hole is made in the inner tube, air will rush out because the pressure of the air inside the tyre is so much greater than the pressure of air outside. The tyre will become deflated. When the hole is very small, it is difficult to find the place of leakage. The usual method is to remove the inner tube, inflate it, and place a section of the blown-up tube under water. Bubbles of air will be seen rapidly rising from the punctured spot. To repair the leakage is quite easy. The rubber round the spot is cleaned with a little petrol and rubbed with glass paper. Rubber solution is then spread thinly around the hole. This consists of rubber dissolved in some spirit. Another piece of rubber, called a "patch," of the size to cover the hole and provide a good margin around, is prepared. It is cleaned and treated with rubber solution. The solution is allowed to dry for a short time. This it does quickly because the spirit is very volatile. When the spirit is almost all evaporated, the patch is pressed down over the space treated with solution on the tyre. The two stick together and when all the spirit has evaporated they are held by a fine layer of rubber. Thus, the hole is effectively stopped up.

Sometimes the tyre still deflates even when there is no puncture in the inner tube. It will be found that the valve rubber is defective. A new rubber should be fitted to the valve and all will be well. Quite an interesting lesson can be given in which a puncture is actually mended.

Motor-tyre Valve

Motor-car tyres are generally fitted with another type of valve. The valve inside con-

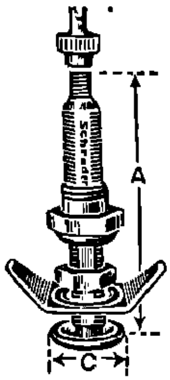


By courtesy of Messrs A. Schrader's

FIG. 45

Section Diagram of Tyre Valve

sists of a metal top which screws down into the valve sleeve. At its lower end is a metal flange covered with rubber. This prevents loss of air past the head. Down the centre is a metal rod ending in a metal tripod. A spring surrounds the lower part of the rod and is attached to the tripod at the bottom. The upper end of the spring has a rim of metal attached. The centre of this rim is filled with red rubber. When the valve is in place, the air cannot escape because the red rubber presses against the air inlet. Air forced in through a pump finds its way past the rubber pad. When the tyre is fully inflated, a cap is screwed on top of the valve. This cap has a special device on its upper side which can be used to screw and unscrew the valve inside into place. The teacher can purchase one of the valve fittings for a few pence. (See Figs. 45 and 46.)



By courtesy of Messrs. A. Schrader's

FIG. 46
A Tyre Valve

Tyre Gauges

These are used to test the air pressure inside inner tubes In the motor-tyre valve, the central rod can be depressed; when this is done, air rushes from the tube The gauge has a ball-foot, which is pressed over the valve. This is so made that the central pillar is depressed. Thus the air within the tube can exert pressure against the inside of the gauge. This pressure moves a spring and the extent of the pressure is measured on a dial which is driven out a distance proportional to the pressure. A scale is provided so that the motorist knows whether the tyres are hard enough.

CLOCKS AND WATCHES

The familiar question of Helen's Babies, "What makes the wheels go round?" is often asked by children when they look at a clock or a watch. It is not possible to give a complete answer, but Junior School children will be quite content with explanations of main principles. The teacher is recommended to collect some old clocks and watches for use in the lessons. Experiment on a favourite timepiece may lessen its value!

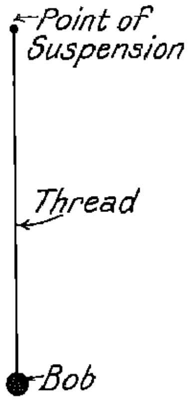


FIG. 47
A Simple Pendulum

The Pendulum

Tie a small weight on to a length of twine. This can serve as a simple pendulum.

By demonstration, prove—

1. That the time taken for the bob to swing from side to side is constant for a given length of string.

2. That the time taken by a long pendulum to swing from side to side is greater than that taken by the bob of a small pendulum.

3. That a swinging pendulum could be used as a time indicator.

4. That a pendulum can be made of such a length that a swing from side to side *and* back again would take *one* second. This is called the seconds pendulum and would be about 39 in. long.

Now, in all clocks containing a pendulum, the rate of the clock is regulated by the rate of the swing of the pendulum. The next problem is to see how the swing can be made to control the movement.

The Escapement

The top of the pendulum is connected with an axis which is provided with a device known as an escapement. The escapement in commonest use is in the shape of an anchor, and it has inturned teeth known as pallets at its prongs. In some clocks this escapement rides over a toothed wheel known as the escapement wheel.

In others, the escapement is on the side. The pendulum is suspended in such types from a pivot, and a wire known as the crutch leads from the escapement and encircles the pendulum so that the movement of the escapement transmitted to the pendulum and the power of the movement can keep the pendulum swinging.

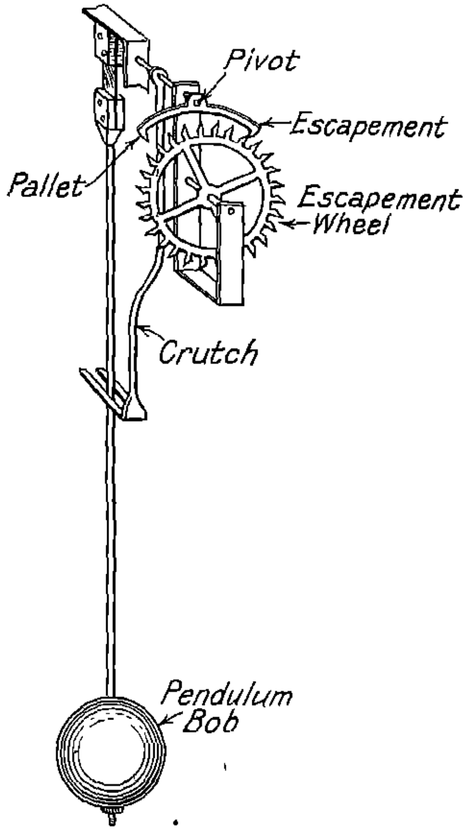


FIG. 48
Some Parts of a Clock

The wheels of the clock are driven by either a spring or falling weights.

The Spring

In the spring-driven clock the uncoiling spring turns the main wheel axle or arbor to which it is fastened. Without going into detail, it can be said that all the wheels turn in unison with the movement of the arbor, at different rates, according to their gearing. If there were no checking action the wheels would move continuously and the clock would soon run down. The check is given by the escapement. The escape wheel can only move as permitted by the pallets on the escapement. The pendulum moves the escapement from side to side. At each movement, one cog of the escape wheel can move. Thus, the rate of revolution is controlled by the pendulum. The motive force is, of course, the spring. The wheels to which the hour and minute hands are fixed move at different rates, the one moving twelve times as fast as the other. The difference in the cogs determines this. If the children master this about the clock, they will have learnt sufficient.

A Weight-driven Clock

This must be mentioned as the motive power is different from that in a spring clock. Here, the weights try to turn an axle. The escapement controls the rate of this turning.

An Ordinary Non-pendulum Clock

This introduces another principle; as it is similar to that found in a watch it is worth examining. The driving force is still a spring but the control can no longer be a pendulum. Instead of this, a *balance wheel* is provided. The balance wheel is a fly-wheel mounted in two very accurate pivots so that it can turn freely in them. To this balance wheel, a hair-spring is attached; the coiling and uncoiling of this spring cause the balance wheel to move backward and forward. If a clock or watch with a balance wheel and spring is examined when the spring of the instrument is run down it will be found that the wheel moves backward and forward when given an impetus. The arc through which the wheel moves gets less and less, but the time of each vibration is the same (compare swing of pendulum).

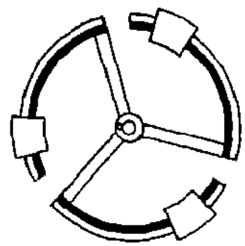


FIG. 49
A Balance Wheel

In the pendulum clock, an impetus to the

pendulum was continually given by the movement of the crutch. In the balance-wheel type the hair-spring and wheel are connected to an escapement and both the rate of the main movements of the wheels and the impulse of the spring are given through the escapement. There is no crutch. On the central axis of the balance-wheel, but a little out of the centre, is a pin (the impulse pin). A rod with a forked end is attached to the escapement, and the prongs engage with the impulse pin. In order that there may be a properly balanced instrument, the other end of the forked rod is enlarged. Examination of a lever watch will show the balance wheel, hair-spring, impulse pin, and rod from the escapement.

THE KITCHEN

Knives and forks, spoons, kettles, and saucepans are objects in such common use that some place for a talk on these must be found.

Metals used in the Home

Iron is rarely found as pure metal, generally combined with other elements as ore The chief ores of iron are: *haematite* or red iron oxide found in Cumberland and some parts of the Midlands (here in somewhat different form); *magnetite* or black oxide found mainly in Norway and Sweden; *clay ironstone* found near coal seams; *iron pyrites*, iron in combination with sulphur.

Smelting consists of heating iron ore, limestone, and coal in a blast furnace. Pig-iron is obtained.

Cast iron is made by melting pig-iron and pouring it into moulds—desk sides are sometimes made of this form of iron It is very brittle; if a break is examined, the crystalline shape can be seen.

Wrought iron has different properties from cast iron. It can be beaten without breaking, and can be drawn out into long wires. Wrought iron is made by heating pig-iron in a special furnace and mixing iron and red iron oxide (haematite) with the molten mass Ploughs, horseshoes, iron nails, and many common articles are made of this kind of iron.

Steel is made by special addition of *carbon* to cast iron or extracting some from wrought iron, which is too rich in carbon. The manufacturers either extract all the carbon from wrought iron and then add sufficient to make steel, or stop the extracting process at the right point. Special furnaces are used. If steel is heated and then cooled suddenly, it has *two* added properties. It becomes very *hard* and *brittle*. Edges of tools are treated in this way so that they are very hard and can cut through very tough materials. *Tempering* is the name given to the hardening process. Chisels, hatchets, and other tools have their edges so treated.

Copper is used for kettles, preserving pans, etc., in the home. It is not a very hard metal and can, therefore, easily be scratched. Copper readily conducts heat and is thus good for vessels in which liquids are to be boiled.

Some copper is found pure in the earth, though the world's supplies are mainly obtained from ores found in the United States and in Burma. In the presence of some acids or in damp air a green substance known as *verdigris* forms. Copper is a good conductor of electricity and is therefore used to convey electricity in cables and house wires. It does not readily tarnish in water and is useful for boilers, kettles, etc. Ships' bottoms are plated with it.

Tin was one of the earliest metals to be used The Ancient Britons used it. It is obtained from tin ore, and is expensive One of its chief uses is to coat iron sheets which are used for cans or "tins." The tin does not tarnish. Iron would if exposed to the air. Prove this by scratching a tin and exposing it to the air. Where the tin is scratched off and the iron left open to the air, rust occurs.

Alloys are intimate mixtures of metals. Here are some of the chief used in the home, etc —

Brass: Copper, two-thirds; zinc, one-third. Ornaments, vases, etc.

Gun-metal: Copper, three-quarters; zinc, one-quarter. Watches, hearth "irons," etc.

German Silver: Copper, 51 per cent; nickel, 26 per cent; zinc, 22 per cent (proportions not constant). Spoons, forks, etc.

Silver is a rarer metal and, of course, some spoons and forks are made of this.

Electroplating of forks and spoons made of German silver is a process too difficult to explain to Juniors. Suffice it to say that an electric current is passed through a solution of chemicals. A bar of the metal to be deposited is placed at one end where the current enters, and the articles to be plated at the other. When the current is switched on, then a thin layer of the valuable metal is deposited on the articles made of a less valuable metal.

Nickel plating and gold plating are also practised.

Household Knives

Knives consist of the blade fastened into a handle The blades of most knives are made of crucible steel forged by hand or machine. Steel is more expensive than iron, and in some cases the edge only is of steel, the other part of the blade being iron; the two metals are welded together. Where this is the case, the blade will not take a cutting edge when the steel strip has worn away. The piece of metal that fits into the handle is called the *tang* and the knife shoulder is known as the *bolster*. Many processes are necessary to make a knife—forging, hardening, grinding, and polishing. Sheffield is the centre of the industry. Grinding stones of suitable texture can be quarried near. Germany and the U.S.A are also large manufacturers.

Stainless knives are made from steel to which *chromium* has been added. *Manganese* added to steel makes it harder.

Abrasives are substances which are used to clean surfaces by rubbing off the top surface. When knives are cleaned they are sometimes rubbed with *bath-brick*. Here, bath-brick is the abrasive.

Abrasives are used in the home to remove tarnish on metals. Soft metals require a less hard abrasive. Some of the common abrasives are Steel wool (made of strands of steel tangled up), bath-brick (obtained from the river bed at Bridgwater), rouge (an iron compound in its cheaper form), rotten-stone (a rocky substance). Different metals should be obtained and examined. A number of abrasives should be bought and experiments made to find their most suitable uses, and to find also what causes tarnish—acids, soda, moisture, etc. Action of metal polish on metals, of paraffin, etc., can be demonstrated.

Heating Water

Experiments suggested in connection with the thermometer show that when substances are heated they generally get larger A kettle filled to the brim if placed on the fire or stove will overflow before it boils because although the volume of the kettle itself increases, the volume of the water more rapidly increases. Prove this to a class and point out the folly of filling vessels of any kind to the brim.

Evaporation

A pool of water in the road vanishes in fine weather. The water on the surface of the pool has turned to vapour. The air has absorbed this. More vapour has been made and will continue to be as long as the air can hold it. In damp weather the air cannot do this.

Boiling

In boiling, heat is transmitted to *all* the water, and at a certain temperature steam is made. At first, bubbles of steam made near the base of the kettle are condensed back to water before they reach the surface. When the water is at 212° F., the bubbles of steam can come out. Steam occupies hundreds of times more volume than the water from which it is made. Explain the danger of filling the kettle too full, or of having a lid too tight. Explain the action of a whistling kettle, where the steam gives warning that the water is boiling.

Conductors of Heat

Some substances conduct heat readily Metals do this. If the whole of a teapot or kettle is made of metal, the handle becomes too hot to hold. Hence, the need for kettle holders. In some teapots, little pieces of wood are inserted in the handle so that the central part is kept cool Heat does not readily pass through wood Notice also wooden handles on kettles

Tea cosies are made of material packed with

cotton-wool or some other substance which does not conduct heat readily Thus, the heat is kept in the pot.

Fur in a kettle is mineral substance deposited from the water. It is a bad conductor of heat and, therefore, "fur" should be scraped out of the kettle.

Making a Fire

Certain substances will burn in the presence of air, which contains oxygen. In making a fire, the principle to be adopted is to lay the materials so that fire is encouraged. Paper at the bottom —is dry, has a large surface, is thin, and ignites easily. Flames rise upward. Sticks above, laid so that air can circulate, ignite less easily than paper, but give greater heat. This heat will ignite small lumps of coal placed above.

Inflammable Substances

Show how small pieces of wool, silk, cotton, and flannelette burn in a flame. From this point out the danger of flannelette as clothing. Show idea of fire-proofing by dipping each in brine and then drying All ignite with greater difficulty afterwards, because the layer of salt on the outside will not combine with the oxygen of the air. Further the salt fills up the air spaces between the threads.

Solutions

Boil up in turn sand, sugar, salt, and other common substances with water. Which dissolve? Prove this fact by evaporating a little of the solution in each case.

Filtration

Make a funnel out of blotting paper. Stir up sand in water and filter the liquid. Prove that the sand does not pass through the filter paper. Filter some brine. Show, the salt does pass through. Discuss the method of separating a mixture of sand and sugar.

AMUSEMENTS OF TO-DAY

This section has dealt with common things met with in everyday life Small children are very inquisitive and questions are frequently asked about the amusements of to-day. How does a gramophone work? How are records made? How are photographs taken? are typical questions. Whilst it is impossible in the space of this book to give full explanations, yet a few notes may be of assistance to teachers when such inquiries are made, and the older Juniors may at least gain the foundations of a scientific conception of light and sound.

Light

In order to understand simply the principles upon which the camera, magic lantern, and cinematograph are developed it is necessary first to know something about the elementary principles of light. For all practical purposes upon this planet, in spite of the Einstein theory, light travels in straight lines. Stick two pins upright in a desk. Now look along the line between them and place another pin so that it is between the first two pins and in a line with them. Notice that all the pins are then in the same straight line. The ray of light from the farthest pin travels in a straight line to the eye and is in the same straight line with the other two pins. Similarly, if three screens are arranged with pin holes at equal heights from the bases, then the flame of a candle can only be viewed through the three holes when the pin holes are in the same straight line.

Now if light travels in this way then the image obtained when a light or object is viewed through a small hole must be inverted. The diagram (Fig. 50) will make this clear, and should be copied on to the blackboard.

The tip of the candle a will be seen on the screen at a_1. If the screen is formed of tissue paper and the experiment is done in a dark room, then the inverted image of the candle will be seen faintly on the tissue paper.

The Camera

The simplest camera consists of a box, made quite black inside, with a tiny pin hole in one end. At the opposite end of the box a plate of glass coated with wonderful chemicals is placed. When the pin-hole is uncovered light enters the box and an image of the object in front of the "pin-hole" camera is formed on the plate. Now the chemicals are affected by light. The hole is covered up again after a certain time, depending on the brightness of the light, and the plate is removed to a dark room. By treatment with chemicals, in what is known as fixing and developing, the light parts of the object are seen

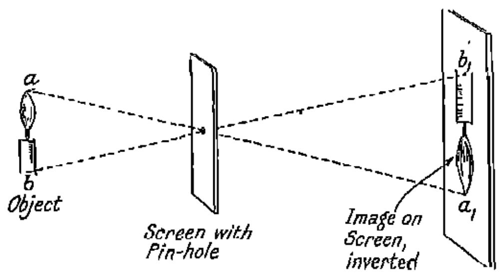


FIG 50

Experiment to show Inverted Image of an Object when Light Passes Through a Small Hole

as dark parts on the glass plate, and the dark patches of the object are quite clear. As the lights and shadows on the plate are opposite to reality the developed plate is known as a *negative*. The negative is then dried and placed against special printing paper. This paper is affected by light very similarly to the plate. Now light acts through the clear parts of the negative but not through the dark parts. Thus a positive picture results.

In a proper camera there are several other parts besides the pin-hole, the box, and the sensitive plate. There are—

1. The shutter, which opens and closes automatically, and so allows light to be admitted for a definite interval.

2. The diaphragm, which allows the entrance of light to be through a small or large hole.

3. The lens, which focuses the image on the plate and thus allows a larger hole to be used, more light to be admitted, and therefore permits photographs to be taken almost instantly.

4. The bellows, a device which enables the "box" to be longer or shorter and allows the image to be focused more sharply. In some cameras the image can be viewed on a ground-glass screen before the "plate" is inserted, and

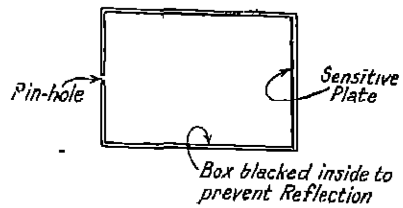


FIG. 51

Diagram of Box Camera

the bellows can be adjusted to get the clearest image.

The Magic Lantern

This is somewhat similar to a camera in principle.

The slide is a positive picture or photograph on glass or celluloid. It is obtained by printing on glass from a negative made with a camera. The body of the magic lantern consists of a powerful lamp. The light is often made by the flame of oxy-hydrogen burning against a cylinder

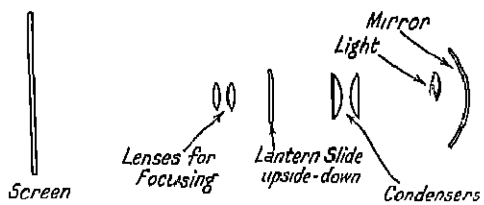


FIG. 52

Diagram of Magic Lantern

of lime This gives out a white and dazzling light. The light is focused on the slide by means of powerful lenses which form the condenser. On the other side of the slide is another set of lenses which focus the image of the slide on the screen. The slide is put into the lantern upside down.

The Cinematograph

The cinematograph, which projects "living pictures" on the screen, is based upon the principle of the magic lantern. Photographs of moving people, animals, or things are taken rapidly one after the other on a strip of sensitive film made of celluloid or similar substance. From this film a positive is made Instead of showing lantern slides, these little pictures are projected one after the other on the screen. Now these little pictures are shown at the rate of about a hundred a second. The eye is not able to get rid of the impression of a picture in less than one-tenth of a second. So before the impression of one picture has faded from the eye the next one has appeared, and the pictures appear to run into one another, and thus appear "alive." Proof of this persistence of vision can be seen when a glowing stick is whirled round. A circle of fire appears to be formed *Catherine-wheel* fireworks depend on this fact for their wheel-like appearance.

Sound

Naturally the next question which arises is that of "talkie films." How is it that not only movement but speech and music are produced? Before dealing with this something must be said about the cause of sound.

During the War bomb explosions would sometimes cause a row of houses quite a good distance away to be shaken down. Thunder often causes articles hanging from a shelf to rattle. Sound is caused when anything vibrates in air. An alarum clock bell can be heard until the clock is hung inside a jar from which all the air has been pumped. When a harp string is plucked, it vibrates and transmits movement to the air, and a sound wave is formed of a definite length. This air-movement finally reaches the ear and in turn causes the ear-drum to vibrate, and by means of delicate apparatus and nerves within the head sound is heard and interpreted. When a flute or tin whistle is blown, vibrations are set up in the air. An organ pipe causes similar vibrations. Low notes are made by long vibrations and high-pitched notes are caused by short vibrations. Thus short waves give high notes, long waves give low notes. If it were possible to live in a vacuum, then pianos could be played, harps could be plucked, and whistles blown and yet no sound would be heard.

The Gramophone

This instrument depends on the effect of the sound waves in air.

First a record of the sound waves is made on wax. The recording machine consists of a trumpet with a diaphragm of very thin material (glass or celluloid) at the base. This diaphragm has a needle attached at its centre. The needle point rests on a rotating disc. The singer or speaker stands in front of the trumpet and performs. Sound waves are caused. These pass down the trumpet and make the diaphragm vibrate according to the type of sound wave caused. The needle makes a cut into the disc, varying with the sound. (Of course, there is no need to explain all the intricacies to Juniors). The record can then be removed and placed in a reproducing machine. In this the record revolves, the needle moves up and down or right and left in the channel cut, and causes the diaphragm to vibrate. This in turn makes sound waves in the air which, when heard, sound exactly like those produced by the singer or speaker. It would be very expensive to get only one record when a noted singer performed or a band played, so that gramophone companies take moulds of the original record and can thus make thousands from one record. They are thus able to sell them cheaply.

The Telephone

When a person speaks into a telephone, sound waves are made. These waves cause the thin plate just inside the mouthpiece to vibrate. By a wonderful arrangement the sound waves are turned into electrical waves. At the other end the electrical waves cause another thin plate of metal to vibrate in the same way as that at the speaker's end. The listener hears these sound waves which are exactly like those made by the speaker at his end.

Wireless

In rather a more complicated way, the thin plate in a microphone vibrates and causes

changes in electrical waves. These waves are transmitted through the ether. The wireless set picks up these and in the "loud speaker" a diaphragm vibrates and gives waves in the air which make sound. (The method of converting sound into electrical waves, transmitting and receiving these is too difficult to be explained to Juniors. It will be found, however, that many boys have a surprisingly good fund of practical knowledge of wireless sets, and this may be used in class discussions as a valuable exercise in reducing knowledge to coherent speech.)

Sound Films

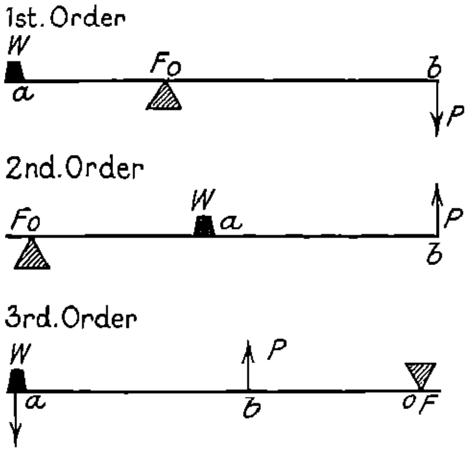
The sounds which accompany moving pictures are made by several methods. In one method gramophone records are used, and by special apparatus arrangements are made so that the sounds synchronize with the pictures shown. In another system use is made of light rays to control the sound waves. A record of the sound is represented by markings on the side of the film. The method is too difficult to explain here.

SUGGESTIONS FOR FURTHER WORK

Amongst many other subjects suitable for lessons in the Junior School, the following also might be noticed. Brief notes which may be helpful are appended.

Levers

If the principle of the lever is explained to a class many interesting lessons on the application



F=Fulcrum W=Weight P=Power
In all cases: Weight x distance ao = Power x distance bo.

FIG. 53

The Three Orders of Levers

of the principle can follow. A lever is a simple machine. It generally consists of a bar resting on a fixed point or edge. This point is called the fulcrum. Forces at work where a lever is used are: (*a*) the weight or resistance, (*b*) the power. There are three orders of levers, the position of the fulcrum, and the relation of the power and weight deciding to which order a lever belongs.

First Order—fulcrum in the middle, weight on one side of the fulcrum, the power on the other.

Examples. Crowbar used to lift a weight, where crowbar rests on projection to form a fulcrum; chemical balances; shop scales; see-saw (each person in turn acts as weight and as power), poker used to lift coal within the grate (the bar acts as fulcrum); steelyard; scissors and pincers are examples of *double* levers of the first order.

Second Order—fulcrum at one end, weight in middle, power applied at other end.

Examples. Wheelbarrow (fulcrum is axle of wheel); oar in rowing (fulcrum is the water, weight or resistance at rowlock); when a door is opened or closed by pushing (or pulling) the handle the principle of the second order of lever is used; nutcrackers serve as a double lever of the second order.

Third Order—power between fulcrum and weight.

Examples. Forearm moving about elbow joint pushing door near hinges; treadle of a lathe; sugar tongs and coal tongs examples of double levers of the third order.

Relation of Distance of Weight and Power from Fulcrum

In all levers the following rule can be applied—Power × length of power arm = weight ×

length of weight arm. (Note length of power arm = distance from point of application of power to the fulcrum.) This can be proved by balancing a light rod on a ledge and placing different weights on each side of the fulcrum at such points as will cause the rod to balance There are other methods, which are, however, unsuitable for the Junior School. Incidentally the rule explains why, when a boy and man see-saw together, the distance of the boy from the balancing point must be greater than the distance of the man from the same point. It is possible to explain, too, why the application of a small force can be made to lift a heavy weight. Notice that when a small child lifts a large stone with a crowbar the child's hand moves through a considerable distance, but the stone is only moved slightly.

Locks of Doors

Obtain various forms of locks from a friendly ironmonger. Types suitable are—

1. Four-lever latch lock. After removing the plate, notice the following: (*a*) The four plates, one on top of the other, similar in shape, except that the opening on each at one corner where the key fits is different. (*b*) The springs which keep these plates in position. (*c*) The spring which presses the bolt in position. (*d*) The grooves along which the bolt slides.

2. Ward Tumbler mortise lock. This fits flush into the end of the door.

3. A padlock with the top removed.

4. A Yale pattern lock. This works on an entirely different principle. There are four or five pin tumblers which drop down and prevent the latch being turned. The key is so cut that it raises each of these tumblers sufficiently to allow free movement of the latch.

Sash Windows

Examination of the window frames will show that there are little panels which can be removed. Inside the frame are weights attached to ropes, which balance the window frames so that it is easy to raise and lower the windows. In some schools, the lower and upper window frames are connected so that when the lower window is raised the upper window is lowered.

Building Materials

Examine the structure, shape, and size of bricks. Find how much water they will absorb. Find various kinds of tiles, and see how these interlock on roofs. Notice the way in which slate is made up of various layers. Mix up cement with a little water and allow to set hard. Find whether it will set under water. Stir a little sand, cement and pebbles together and make concrete Make cement tiles, coloured with pigments, in a wooden mould. Find the different kinds of timber used in a building What metals are used?

Domestic Utensils

Why are saucepans, frying-pans, etc., so shaped? Why are non-conducting materials placed on the handles? What is a steamer? How does it work? Why is a colander provided with holes? How does a coffee percolator work?

Visual Aids

Only the simplest experimental work is possible in the Junior School, but a very live interest in science can be established. Pictures, films, and such film-strips as the Pitman Science strips will help to establish the right foundation for Secondary work.